



OUT OF THIS WORLD

BY

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*To fellow Earth-people, as they prepare to go
out of this world.*

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Dr. Dan Q. Posin

From Einstein, Variety and The New York Times

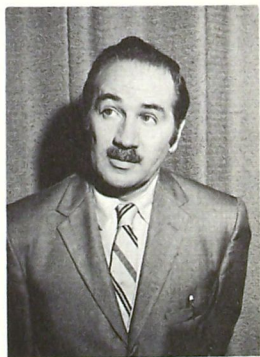
"I have read your whole book and admire sincerely your energy. . . . Not less extraordinary I find your pedagogic talents." — *Contained in a letter from Dr. Albert Einstein to the author concerning another book by Dr. Posin.*

"Dr. Daniel Q. Posin, a physics professor, is a delightful tv lecturer. He's a popularizer of the sciences of the first order. His gift doesn't rest solely in simplification but more in his personality which bubbles, laughs, and lights up his subject." — *Variety*, June 3, 1959.

"Dr. Daniel Q. Posin is a lively pedant endowed with abundant energy and a delivery that comes close to Lou Holtz on the brink of telling a joke. The physics professor's punch lines may detonate laughter but the fall-out also besprinkles his audience with fragments of knowledge essential to an understanding of the universe. . . .

"When the physicist talks about electrical waves he undulates on screen so that his audience may visualize what happens . . . he supplies not only the science but also the imagination needed to make viewers true men of vision.

"His explanations of space are replete with orthodox formulas and learning." — *The New York Times*, July 12, 1959.



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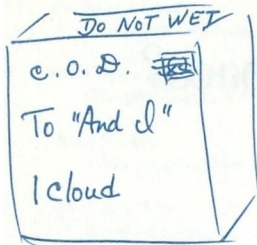
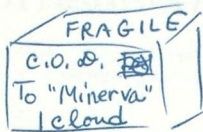
Anyone for Space?

MINERVA AND I are very much interested in space. Minerva, named for the Goddess of Wisdom, likes astronomy and goes out every night to study the stars. She insists on going out even when the sky is overcast. She must have very good eyes to penetrate the cloud-cover, or else she has an awareness that is strange to mere people of Earth.



For a long time Minerva has been helping me on a television show about space called "Out of This World." Both she and I are growing increasingly anxious to sail out into the heavens, to the planets and to the stars. We feel, in fact, as though we are already "out there"—far out—and have been looking about us in imagination at the wonders of the Universe.





Also we have been thinking of Earth-people, Earth-cats, and trying to see them as they are—inhabitants of a huge space-ship called Earth captured by the Sun and held in relentless repetitious orbit.

This book is about our dream adventures. Minerva is responsible for the sections on "Mice, Men and Cats," "Extrasensory Perception," "Astronomy in the Dark" and a few others. Perhaps you'll know which ones.

She also has had at least something to do with the chapters "Catastrophe in Space," "Catapult from Earth," "The Milky Way" and other similar categories.

For a long time we have known that our pink clouds would one day arrive for the actual journey through space, and now they are here.

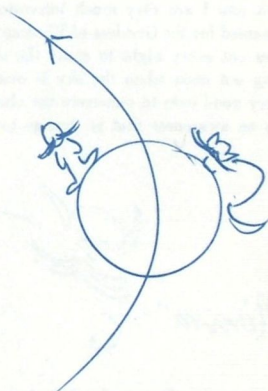
Minerva and I are on our way.

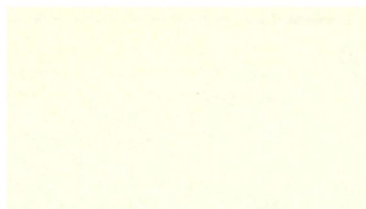
Anybody else?

Anyone for space?

"MINERVA"

"AND I"





OUT OF THIS WORLD

ACKNOWLEDGMENTS

In many ways, this book is a written version of the author's CBS television program, "Out of This World," which originates at WBBM-TV, Chicago. Thus, the author would like to thank those people who are connected with the program: Sis Atlass, Producer; Phil Bondelli, Director; Al Lynds, Artist; Bill, Riley, Fred, and the others, Members of Crew.

Much of this material also corresponds to another of the author's television programs, "Dr. Posin's Universe," on WTTW-TV, Chicago's educational station.

All the marginal drawings were done by the author.

The author also wishes to thank Bob McCoy, Managing Editor, and Art Mikesell, Chief Working Editor (who saw the book through the presses).

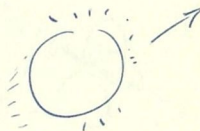
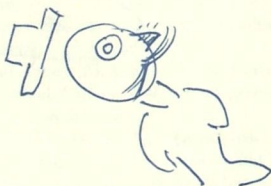
The manuscript was read, checked, and typed by Patsy Posin, Wife.

Much encouragement also derived from Minerva, Cat.

Visitors from Space?

Everyone is welcome.

IT HAPPENED AT PANAMA—on the planet Earth—at the University. The Professor had come to Panama from the University of California, to teach physics and mathematics. On a bright, sunny Earth-day, at about 5 P.M., he stepped out of the University building into the courtyard and suddenly noticed an object in the sky.



It was round, silvery, silent—seemingly determined in its flight, but quiet. Now it was gone, lost on the horizon.

He knew something about meteors, and he knew something about weather balloons. It was not a meteor, and it was not a balloon.

It did not seem to be very high in the shining tropical sky, but of course heights can be deceiving, he realized, with only the sky as a background.



atmosphere
← Mars



Vacuum



That was more than twenty years ago, before the time of the "flying saucer" craze. The experience has stayed with him . . .

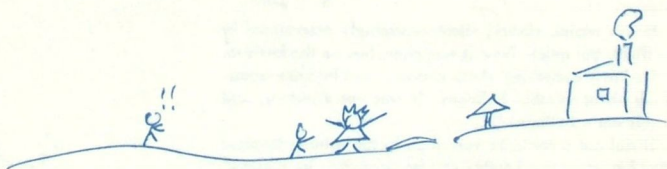
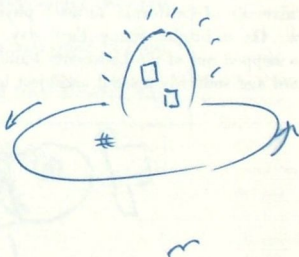
Are there flying saucers? The Earthlings wonder. "Have we been visited by beings from other worlds?" they ask.

Could such devices exist somewhere in the Universe . . . swift, silent, streaming devices, spanning the great oceans of vacuum on the way between planets . . . spanning the vaster oceans of vacuum between solar systems . . . guided by rational beings, intelligent beings, daring, alert, wondrous?

The Professor believes that such devices and such beings do exist.

His friends say, "Where are they? Where do they travel?"

"And how?"



Little Green Men

Or are they blue?

THE FLYING SAUCER BUSINESS got off to its formal start on the planet Earth when an airplane pilot reported seeing nine dazzling saucer-shaped objects buzzing around Mt. Rainier in the State of Washington, June, 1947.

After that a rash of saucer reports broke out over the country called the "United States."

Soon, saucers of unconventional, unsaucerlike shapes were being reported.

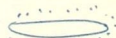
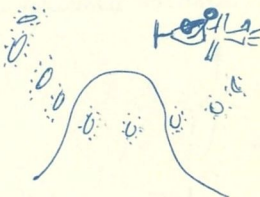
Not all of the saucer reports could be easily laughed off by skeptical Earthlings.

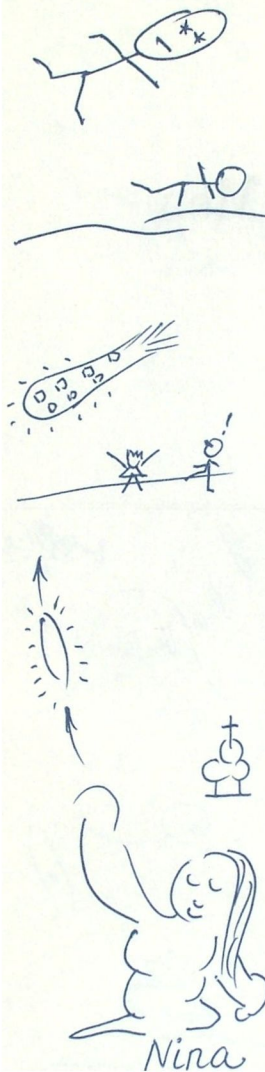
On the evening of August 25, 1951, three professors of the Texas Technological College saw several groups of lights dash silently across the sky.

On the afternoon of July 10, 1947, an Earth astronomer was driving with his family in the region called New Mexico, when suddenly all of them saw "a curious bright object almost motionless in the sky."

On April 24th, 1949, Charles B. Moore, Jr., an aerologist with General Mills Inc. saw a white elliptical object.

One evening in 1949 in Las Cruces, New Mexico, Clyde Tombaugh, the first Earth-man to discover the existence of the planet Pluto, saw—as did his wife and another relative—a "strange" solid "ship" whip across the sky. This device appeared to them to be of an oval shape and





"seemed to trail off at the rear into a shapeless luminescence." The entire object had a blue-green glow, and about six "windows" were distinctly visible at the front of the flying object and at the side. The windows also glowed, they reported, with the blue-green color, but were brighter, dazzling, and had a yellow tinge.

As the number of saucer reports on Earth multiplied, many seemed less reliable.

One Earth-man said he found the wreck of an out-of-this-world flying machine with dead midgets strewn about; another told of conversing with visitors from outer space; a third claimed to have films of flying saucers; a fourth announced he was raising money to build a saucer of his own to "meet the visitors halfway."

All kinds of societies have been formed on the planet, dues have been paid, reports have been made, books have been written and conventions have gathered.

What *are* the flying saucers?

Opinions among Earthlings vary.

Aime Michel, a competent writer and amateur scientist, believes some of the saucers are from outer space. Dr. Donald Menzel, eminent astronomer, believes that all saucers can be accounted for on the basis of reflections of lights, refractions, mirages, balloons, hoaxes, guided missiles, clouds, lens effects of the atmosphere, etc.

A Russian politician-statesman has said, "The flying saucers are the result of the fact that our discus throwers have recently been practicing."

The flying saucers, many Earthlings believe, are certainly not all psychological phenomena or illusions. They are not all missiles, atmospheric disturbances, balloons, hoaxes. Some of them, it is admitted, are merely "shooting stars" or meteors.

"And these," the Earthlings say, "these are, of course, really out of this world. They may be remnants of an exploded planet, and they may even bring some tiny visitors with them—spores, slumbering bacteria, etc.—but no little green men."

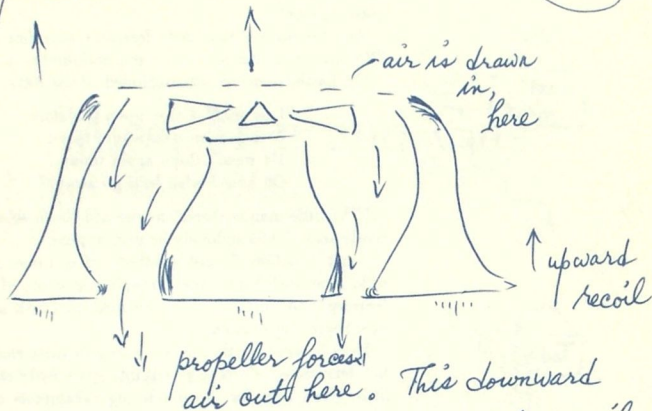
Can such devices as flying saucers even be built? Many Earthlings wonder.

"They certainly can!" enthusiasts reply. And, in fact, they *are* being built right now by the little men of Earth.

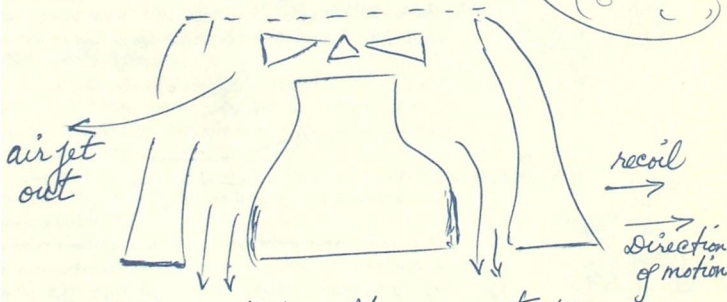
For traveling through their atmosphere, the Earthlings are making machines which combine the helicopter and jet principles.

To travel in vacuum—in outer space—Earthlings have made huge rockets, and they are designing space ships,

upward recoil



This downward forcing gives saucer an upward recoil, or lift.



To travel to the side, a vent opens & some of the air streams to, say, left...

space liners, space sailboats and gigantic cosmic butterflies to flit from planet to planet, as we shall presently see.

"But the question is," insistent Earthlings demand, "have any *genuine* saucers or machines come to us from outer space?"

And the answer that their foremost scientists give is: "Probably not. But they *can* come, and might—any day."

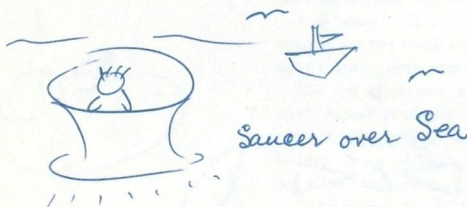
On Earth, someone was reminded of the ditty:

"Last night I saw upon the stair
A little man who wasn't there.
He wasn't there again today,
Oh how I wish he'd go away!"

"The little man is there," a wise old Earth scientist recently said. "And suddenly he may appear."

"And I believe," said another, "that some of these little men will have gone through a process of trying, learning and doing, such as we men on Earth are only now beginning to engage in."

Here is what Earthlings are doing in their elementary but determined efforts to go out into space and become the little green men for the wondering inhabitants of other planets.



Sky Car Over
Land



Earth-people already have these...

Mice, Men and Cats

Also monkeys and dogs.

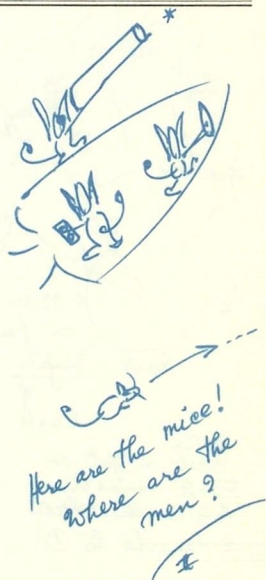
IN FEELING THEIR WAY cautiously into space, Earth people have been using animals such as dogs, monkeys and mice. Some of the animals have lived, others have perished. Some have been shot vertically and have come down by parachute; others have been lobbed across great distances; others have been shot into orbit around the planet itself. The effects of acceleration have been tested, as well as the effects of free fall, of weightlessness, and of cosmic radiation.

The Earth people have found that animals can survive a blast into space and a return to Earth, and so cautious Earth-men themselves now are going traveling spaceward.

The men are going into orbit. They have longed to do this. They have even been singing of traveling around their Earth in 80 days!

The Earthlings of the United States have a plan to put a man into orbit. According to plan, the man will go around the earth 15 times or more before he comes down again, safely. The capsule which is to carry the space adventurer around the Earth will do so, not in 80 days, but in little more than 80 minutes.

The capsule (with occupant) will be launched by an Atlas ICBM. This rocket, using two booster engines and



same rate as the surface of Earth below. Thus a spaceman orbiting 22,000 miles above the equator would be constantly poised above the same spot on Earth. It might even be the spaceman's house. It would be as though a man sat on a flagpole 22,000 miles tall—with the minor difference that there would be no flagpole!

Mercury, in ancient mythology, was for Earth people the messenger of the gods. Very soon now, Mercury will be the messenger of men.

Project Mercury, of course, is the plan to put a man into orbit around Earth; and a fast man he will be indeed, making a circuit around Earth in about $1\frac{1}{2}$ hours. This modern Mercury will be as rugged and as wise—and probably as handsome—as the messenger of the gods. The National Aeronautics and Space Administration (perhaps the temple of the gods among Earth men?) has issued the following specifications:

1. Mr. Mercury must be a university graduate with a degree in the physical sciences or engineering;
2. He must also be a graduate of one of the military test-pilot training schools, with at least 1500 hours of flight time;
3. He must be less than 40 years old, and no taller than 5 feet 11 inches;
4. His physical condition must be ultrasuperior, and his physical and psychological qualities must be suited to space flight.

The selection of this Mercury of the Earthlings began with a list of 100 candidates which was later narrowed down to seven semifinalists during training at Air Force biomedical centers. The aspiring Mercuries undergo centrifuge tests which simulate the conditions in the capsule during take-off and re-entry. There will also be balloon flights in Mercury capsules to accustom the spacemen to their home in the sky.

Practice shots will be made to launch capsules carrying dummy passengers and equipment, first with short-range solid-fuel boosters, later with more powerful boosters. Animals then will be launched in a series of capsules before the actual Earthling Mercury goes aloft.

While Mr. Mercury is in orbit, instruments will record his psychological and physiological reactions to the effects of weightlessness, of high acceleration during launching, and of high deceleration during the re-entry into the atmosphere.

The re-entry can be achieved by several methods. In

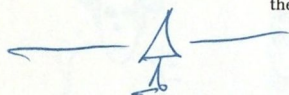


the "ballistic" method a rocket is fired from the capsule in the direction of flight to slow down the capsule, making it drop out of orbit. A set of parachutes then slows it down even more and finally brings the heroic Mr. Mercury down to Earth. In the "glide" method, a capsule which is part glider is used. After a braking charge is fired, the capsule-glider makes use of the atmosphere both for deceleration and support as it traces a long, descending path, going several times around the Earth before landing.

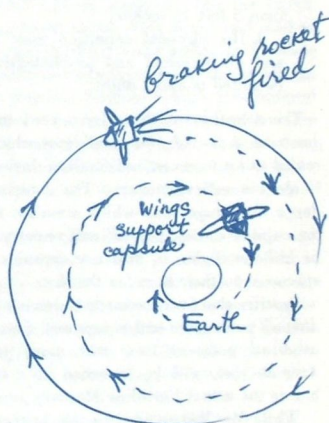
Earth people sometimes wonder if it is true that the first man into space will be a woman?

The answer is, in the United States at least, the man will be a man. The Russian Earthlings have said that women may be better suited for such a flight. No doubt U.S. women will eventually go aloft—to see what their men are doing.

But how is all this achievable? How will Earth people provide the power to lift objects into space and propel them around the planet?



"Ballistic" Re-Entry



"Glide" Re-Entry

Catapult from Earth

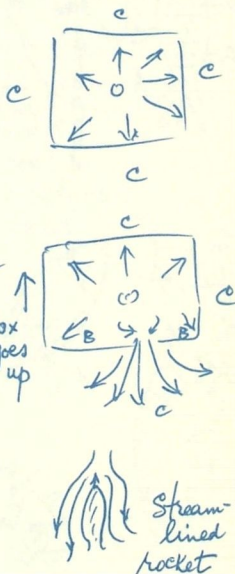
Whirrrrrrr . . . Woosh!

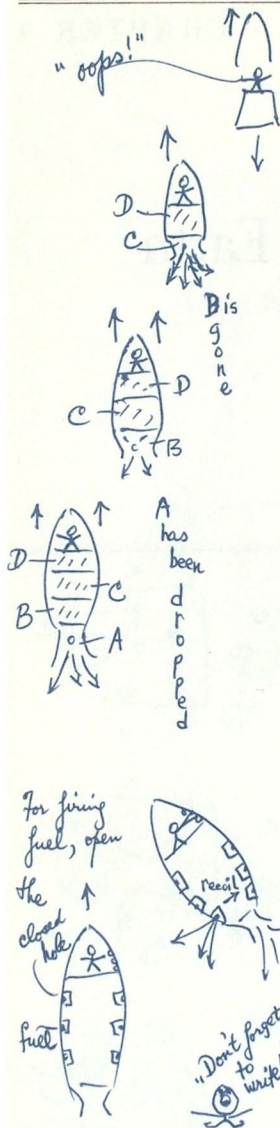
LET US NOW LOOK at an Earth treatise, *On the Operation of Rockets or Space-Ships*:

1. The principle of a rocket may be illustrated as follows: Here is a box with some fuel burning; the box will not move. (Of course, if the walls give way, we will have an explosion; but we are assuming here that the walls will hold.)

Here is a box with a hole in the bottom; some of the hot gases can rush out of the hole, and so there is not much pressure now on the *bottom* of the box. But there is still a pressure on the top of the box, directed upward, due to the gases, *A*. The box now has an imbalance of pressure—more urging it upward, *A*, than downward, *BB*. Therefore, the box will now move upward. If there is no air on the outside of the box, at the sides *C C C C*, then this box (with the hole) will move upward very nicely (if it is not too heavy).

The point here is this: A rocket *does not* need air on the outside "to push against," as so many people think. A rocket travels better through a vacuum. A rocket operates on the principle of recoil: For every action there is a reaction. If a gun fires a bullet, the bullet goes forward and the gun "kicks" back. The external air has nothing to do with it. A firing gun would kick back even





in a vacuum; in fact, it would kick back even more. Of course, if the rocket is to travel through air, it should be streamlined, in order to have it encounter as little as possible frictional opposition due to the external air.

2. Here is a rocket or "space-ship" (this latter term is usually reserved for large rockets which can carry passengers) with several sections, each containing its own fuel compartment; when the fuel is burned up in one compartment, that part of the rocket can be dropped off. Why carry dead weight?

It is considered proper form in space travel not to drop off the passenger, but these are mere details; SCIENCE comes first.

3. A Piggy-Back rocket is one that rides on another, then lets go with a bang, firing its own fuel. Let us say that the two together get up to a speed of 3,000 miles per hour. If the Piggy can produce a speed of its own of 2,000 miles per hour, it will now have an actual speed of 3,000 plus 2,000, or 5,000 miles per hour relative to the ground. So, a Piggy-Back unit can give the Piggy a greater speed than either part could produce alone.

Why not a Piggy on a Piggy? The entire unit with two Piggy attachments takes off and achieves a speed of 3,000 miles per hour. Then the first Piggy achieves a speed of its own of 2,000 miles an hour, and the second Piggy gets up to a speed of 2,500 miles per hour on its own. The result: $3,000 + 2,000 + 2,500$ or 7,500 miles per hour.

4. How do rockets or space-ships turn in space? The operator can have a keyboard in front of him and can open, fire, and close any chamber or chambers merely by playing on the keyboard.

5. If a rocket is fired from Earth at better than 7 miles per second (a mere 25,000 miles per hour), it will outrun the pull of Earth's gravity, and will get completely away. After that perhaps the Moon will capture it, or one of the planets. Actually, in order to overcome the friction of our atmosphere, the firing speed should be greater—say 30,000 miles per hour. One should emphasize that *just one shot of fuel* is required; then the fuel is cut off, and the rocket gets utterly away, on its momentum:

Assume the speed of the rocket is 30,000 miles per hour right off the bat. Then, the fuel is cut off, and the rocket is gone for keeps; it won't fall back to Earth.

However, a take-off at 30,000 mph is very likely to kill the operator; this should not happen, because we

need him for steering, for thinking, and for SCIENCE.

Therefore, a slower take-off is recommended; in which case, however, the fuel must be burned for a longer period of time. Consequently, the space-ship is now heavier since the fuel is not all burned off at the take-off. And since the space-ship is heavier, more fuel must be burned in order to lift it; therefore, more fuel must be carried in order to carry more fuel!

Even so, it can all be done. We should be able to go to the Moon in a few years.

What for?

Who knows?

There is no air on the Moon, no water, no vegetation. But we'll go. Someone is sure to do it. It's better than staying at home. Schopenhauer has said, "Most people prefer even death to boredom." And Bertrand Russell remarks, "People would rather die than think. And they do."

Some go deep down into caves to look for SOMETHING-OR-OTHER, and occasionally die down there. Some go over Niagara Falls in an inner tube; they also occasionally die. Others walk a wire stretched between mountain peaks. Still others race hot-rods, and a few individuals actually long for war. So why not die on the way to the Moon?

The journey will be made. And en route, perhaps, the travelers can study cosmic rays, acceleration, and eventually, other-world Fauna and Flora.

6. How do we land on the Moon? Or on one of the planets? Like this: Fire out of Nose (to reduce speed); dip up, and fire out of tail (to fight off gravity); then settle slowly.

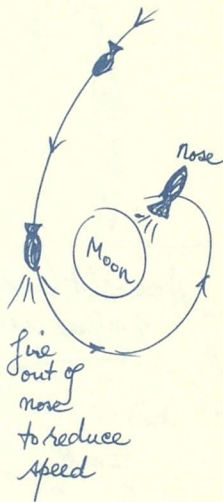
7. Some fuel should have been saved for the return journey from the Moon or Mars.

8. It should take only a few days and nights to go to the Moon. And about a year to go to Mars.

9. If a rocket or space-ship is fired from a high mountain-top, there will be much less friction, because so much of the air is already below the launching site.

10. The velocity of 7 miles per second with which a rocket must be fired if it is to escape from Earth on one fuel shot, is called the "escape velocity." After the initial firing, velocity (on a single shot) decreases due to the Earth's pull on the rocket; but, as we have said, the rocket will still get away—just barely.

At about 216,000 miles from the earth, the rocket has lost all of its original velocity, and barely coasts into the



influence of the Moon. After that, velocity keeps increasing due to gravitational fall toward Moon.

11. If we fire a rocket into empty space (not toward the Moon or any planet at all), with just enough velocity to escape from Earth, the rocket, after escaping Earth's influence, will have no velocity at all; if at this point a little fuel is burned, just for an instant, the rocket will attain a certain velocity, and will continue to move at this velocity forever since it is traveling in a vacuum with no friction to slow it down.

12. One can fire a rocket so that it neither escapes into space, nor falls back to Earth.

How?



A one-shot burst of
7 mi/sec is a little tough
on the astronaut

Earth

Satellites and Orbits

Around the world in 80 minutes.

THE PEOPLE OF EARTH know the answer to this question: "Why doesn't the Moon fall to Earth?"

The answer is: If it were standing still, relative to Earth, and not going around the Earth, the Moon would fall to Earth.

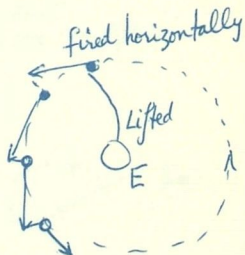
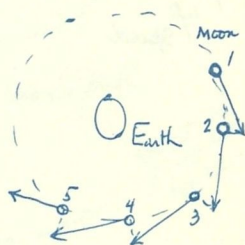
Actually, here is what happens. Because the Moon has a velocity around Earth, the pull of Earth's gravity can only change the direction of flight along the circumference of a circle, as follows:

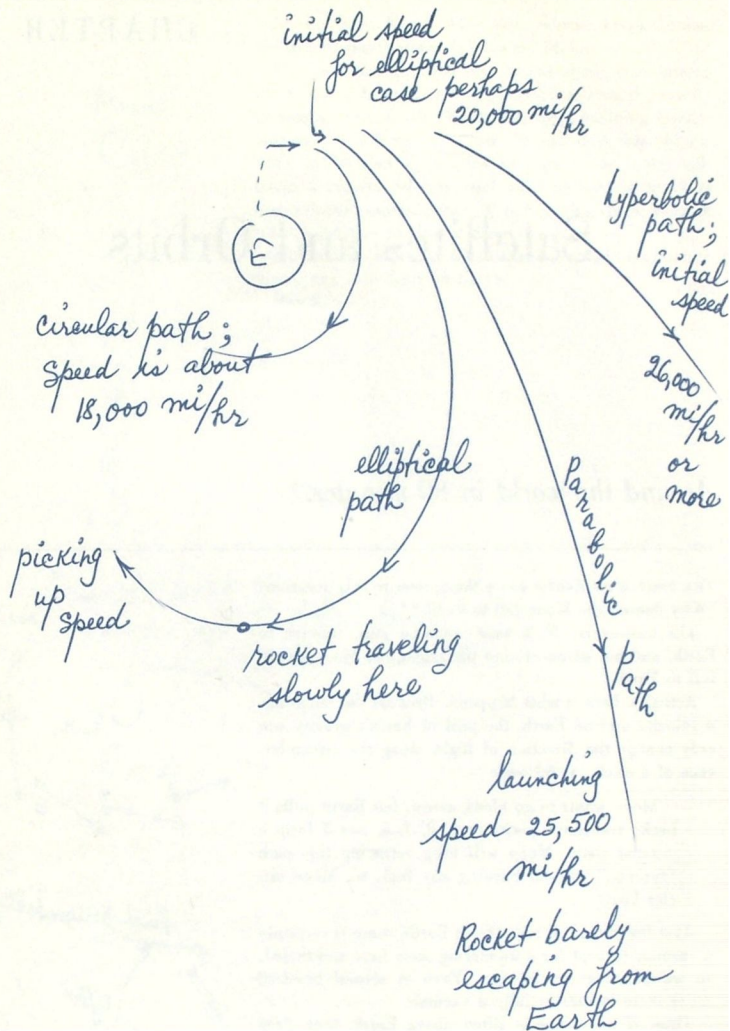
Moon wants to go along arrow, but Earth pulls it back; successive positions 1, 2, 3, 4, and 5 form a circular path. Moon will keep retracing this path "forever," without burning any fuel; so, Moon circles Earth.

At a few thousand miles from Earth, there is certainly a vacuum (except for a wandering atom here and there), so we encounter no friction. Even at several hundred miles there is substantially a vacuum.

Thus, if an object is lifted above Earth, then fired horizontally, it might become an artificial moon—a satellite of Earth—if it is propelled with sufficient speed.

If a rocket is fired at a *greater* speed than 18,000 miles per hour, horizontally, when it is relatively near the

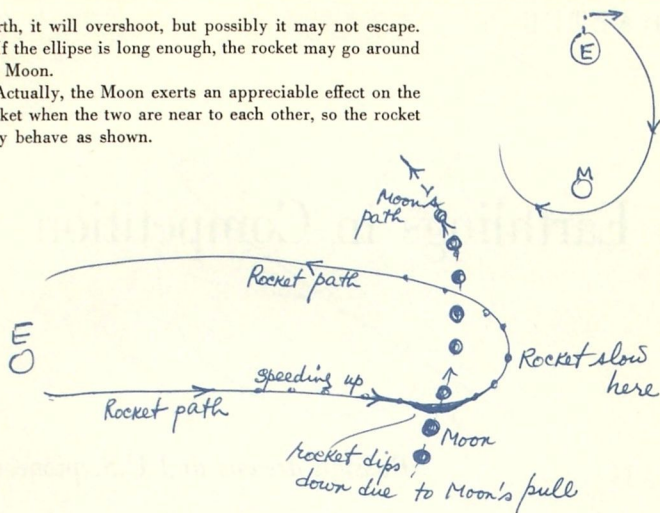




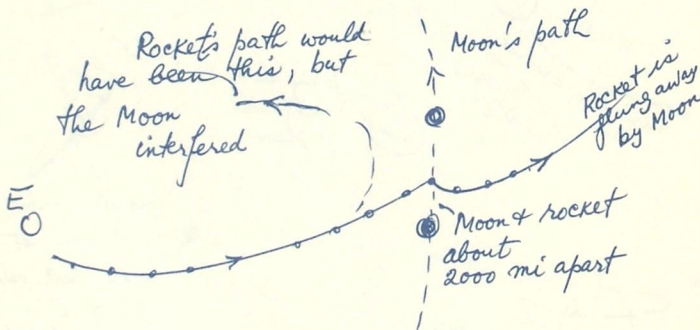
Earth, it will overshoot, but possibly it may not escape.

If the ellipse is long enough, the rocket may go around the Moon.

Actually, the Moon exerts an appreciable effect on the rocket when the two are near to each other, so the rocket may behave as shown.



If the rocket passes fairly close to the Moon . . .



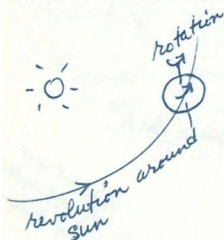
If the rocket comes *very* close to the Moon, it will not be flung away, but, instead, the Moon will yank it around and it will go back to Earth.

Knowing these principles, what have Earth-men achieved?



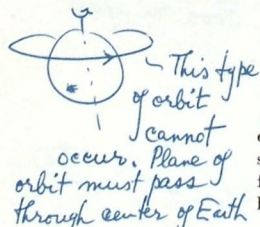
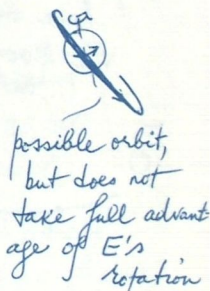
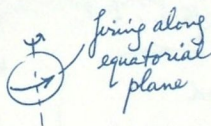
Earthlings in Competition

Russian dreams and U.S. pioneers.



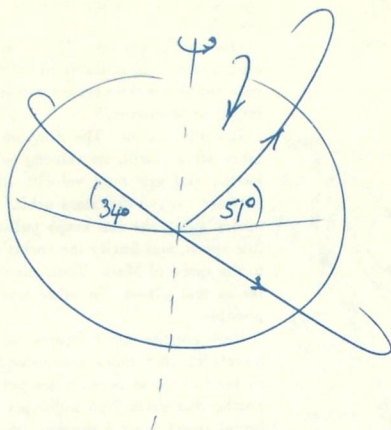
BOTH RUSSIAN AND UNITED STATES Earth-men have shot satellites of various sizes into orbit around their planet.

The planet *rotates* in space, besides traveling around the Sun.

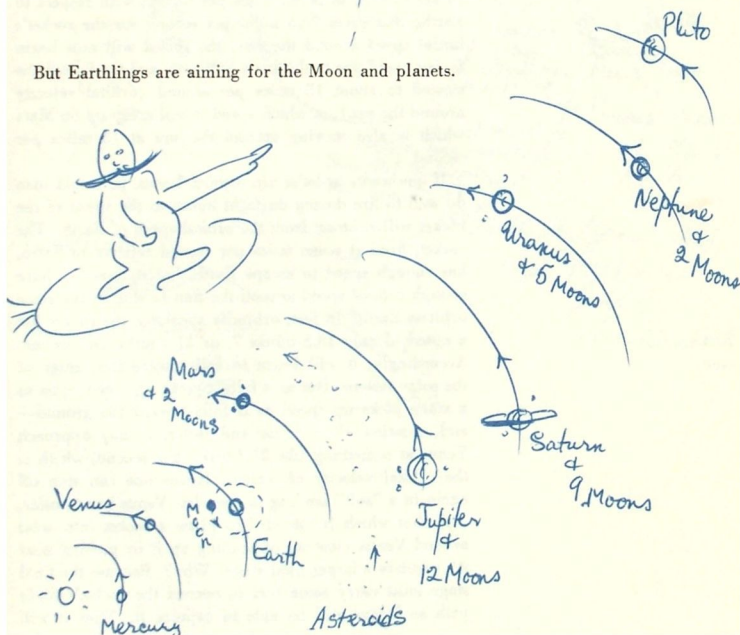


Thus, if an object is fired eastward from Earth at the equator, it will have the benefit of Earth's rotational speed—more than 1,000 miles per hour. If the firing is from a latitude other than the equator, the advantage is less.

Here are some of the orbits Earthlings have achieved, with payload weights ranging from several pounds to thousands of pounds:



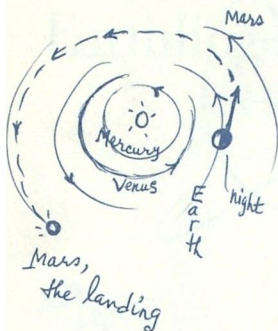
But Earthlings are aiming for the Moon and planets.



The Earthlings know that a shot through space toward Mars should be made at night, but a shot toward Venus should be made during the day. Sounds a little peculiar, doesn't it?

One well might ask, "If you're going to fire something on a journey of millions of miles, what possible difference could it make whether you let'er rip at night or after lunch, or whenever?"

It matters a lot. The diagram shows that if a rocket takes off at night, its velocity will be added to that of Earth; and this total velocity will make the rocket fly outward toward the Mars orbit. However, as the rocket moves away, the sun keeps pulling back on it, makes it lose speed, and finally the rocket's speed may be reduced to the speed of Mars. Then one can make a casual transfer to that planet. In other words, a "soft" landing is possible.



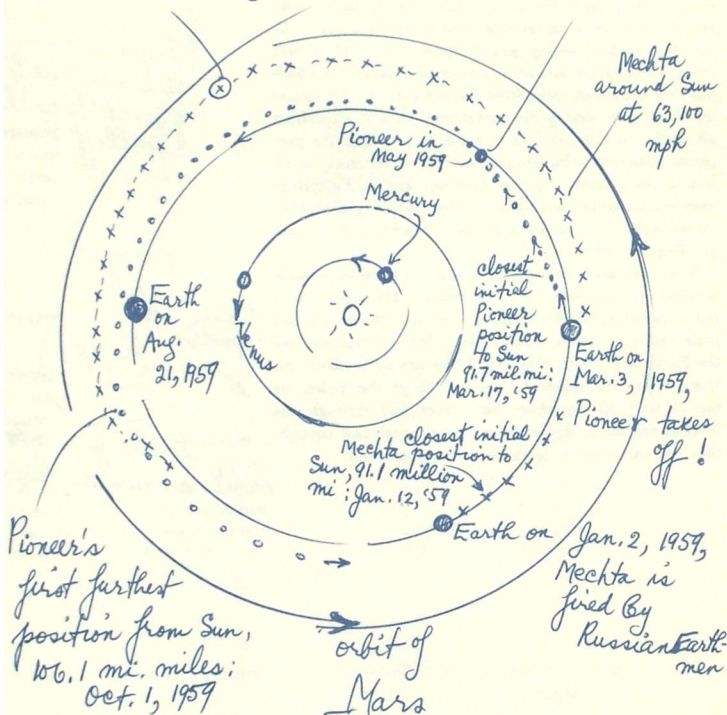
Here are the speed figures for such a venture: Earth travels at 18.5 miles per second around the Sun; the rocket is fired at seven miles per second with respect to Earth; that gives 25.5 miles per second for the rocket's initial speed around the sun; the rocket will now begin *losing speed* due to the sun's pullback, and finally will be slowed to about 15 miles per second (orbital velocity around the sun), at which speed it will creep up on Mars which is also moving around the sun at 15 miles per second.

If one wants to let'er rip toward Venus, he would then do well to fire during daylight hours so the speed of the rocket will *subtract* from the orbital speed of Earth. The rocket, fired at seven miles per second relative to Earth, has enough speed to escape Earth, but it does not have enough *orbital* speed around the Sun to stay in the same orbit as Earth. In fact, orbitally speaking, the rocket has a speed of only 18.5 minus 7, or 11.5 miles per second. Accordingly, it will begin to fall toward the center of the solar system. But as it falls it picks up speed—just as a stone picks up speed as it falls toward the ground—and, coasting along faster and faster, it may approach Venus at something like 21.7 miles per second, which is the orbital velocity of Venus. Hence one can step off again in a "soft" landing to see what Venus has to offer.

A shot which is intended to place a rocket *into orbit* around Venus (instead of landing on it or passing near it) requires a larger final stage. Why? Because the final stage must carry some fuel to correct the rocket's flight path so Venus will be able to capture it. Thus it will

Mechta's furthest position from Sun, on first time around is 120 mil. miles: Aug. 21, 1959

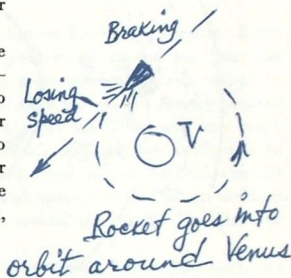
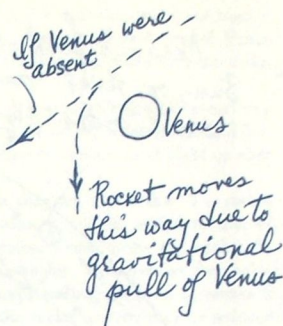
Pioneer around Sun at 64,800 mph



become a satellite of Venus. The best procedure would be to have the rocket traveling fast as it approaches Venus (though not heading directly for it) and fire the fuel in the direction of flight. This would make the rocket lose speed and let the lovely Venus capture her victim.

It's a rather tricky job to fire a rocket and make it go into orbit around Venus or Mars, but it isn't really very hard to fire a rocket into orbit around the Sun. The sun has such a strong gravitational field that it will eventually capture almost any kind of a projectile which has first been shot away from Earth's control. Of course the Earth-man aiming the rocket may send it whooshing off so that it falls straight into the Sun. But if the projectile goes into orbit around the Sun, it becomes, in effect, a new planet. And, as everyone knows, Earthlings have succeeded in creating new baby planets (planetoids) on more than one occasion already. Mechta and Pioneer are diagrammed here.

Some may ask: Isn't space travel going to be impossible because of the deadly radiation zones? The answer is—not impossible, but somewhat perturbing. There are two main radiation zones around Earth, but the regions over the North and South Magnetic Poles are quite clear. So space-ships will either be taking off at the poles, or they'll take off anywhere but travel *fast* through the belts of radiation. If Earthlings get through fast enough, they can sail onward to the heavens, unscathed.



Here are three tables containing information about the planets of the Solar System and their moons:

PLANET	DISTANCE FROM SUN (1,000,000 MILES)	LENGTH OF YEAR (RELATIVE TO EARTH)	VELOCITY OF ESCAPE (MILES PER SECOND)
Mercury	36.0	88 days	2.2
Venus	67.2	224.7 days	6.3
Earth	93.0	365.25 days	7.0
Mars	141.5	1.886 years	3.1
Jupiter	483.3	11.86 years	37.0
Saturn	866.1	29.46 years	22.0
Uranus	1782.5	82.02 years	13.0
Neptune	2783.2	164.79 years	14.0
Pluto	3675.0	248.44 years	6.6

PLANET	RATE OF ROTATION (RELATIVE TO EARTH)	DENSITY (GRAMS PER CC.)	DIAMETER (MILES)
Mercury	88 days	2.86	3,000
Venus	? ? ?	4.86	7,700
Earth	1 day	5.52	7,900
Mars	24 hours, 37 min.	3.96	4,200
Jupiter	9 hours, 55 min.	1.34	86,700
Saturn	10 hours, 14 min.	.71	71,500
Uranus	10 hours, 40 min.	1.27	32,000
Neptune	15 hours, 40 min.	1.58	31,000
Pluto	? ? ? ?	5.3	6,500 (?)

PLANET	GRAVITY (AT SURFACE)	MOONS	DIAMETERS OF MOONS	DISTANCE TO MOONS (MILES)
Mercury	.27	—	—	—
Venus	.85	—	—	—
Earth	1.0	1	2160.0	240,000
Mars	.38	2	10; 5	5,800; 14,600
Jupiter	2.46	12	15 to 3,200	112,600 to 14,800,000
Saturn	1.17	9	300 to 3,550	115,000 to 8,034,000
Uranus	.92	5	150 to 1,000	80,000 to 334,000
Neptune	1.12	2	3,000; 200	220,000 to 5,000,000
Pluto	.9	—	—	— — —

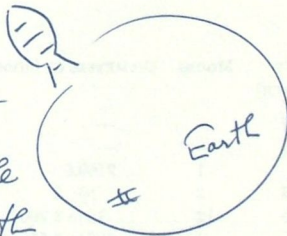
Space Platforms

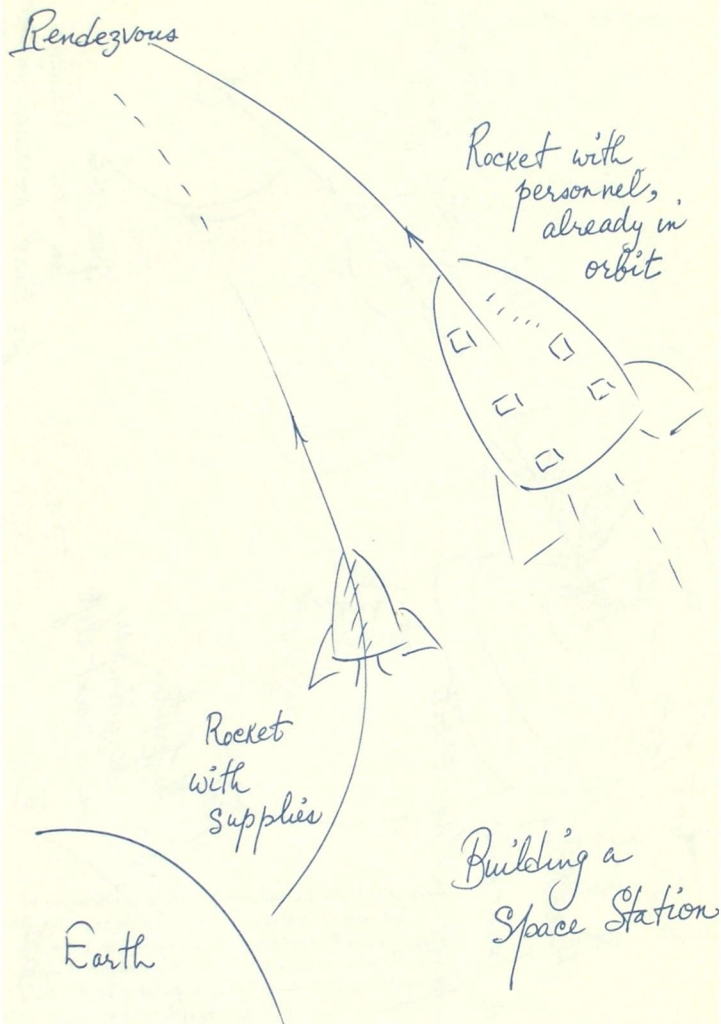
Later, space-ships and space-liners.

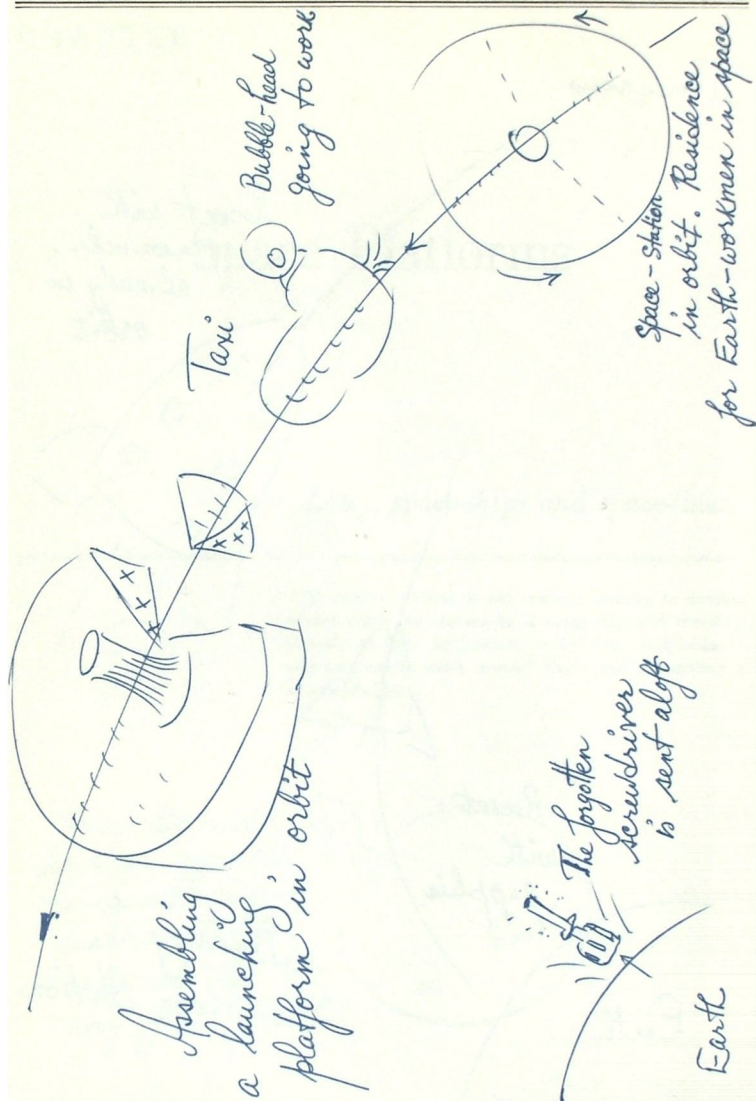


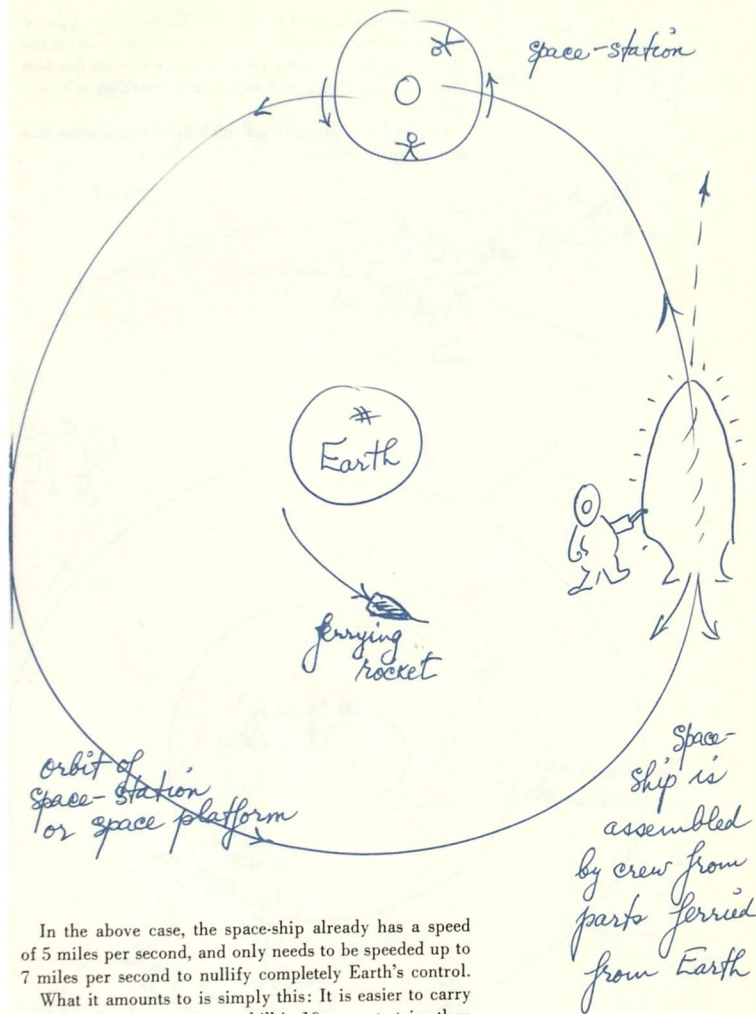
THE PEOPLE OF EARTH can make a journey to another planet either by leaving in a space-ship and traveling directly to their destination, or by first establishing a space-station in orbit around Earth and assembling a space-ship there.

Space-ship must
be super-gigantic
for direct trip —
fuel must be
carried all the
way from Earth





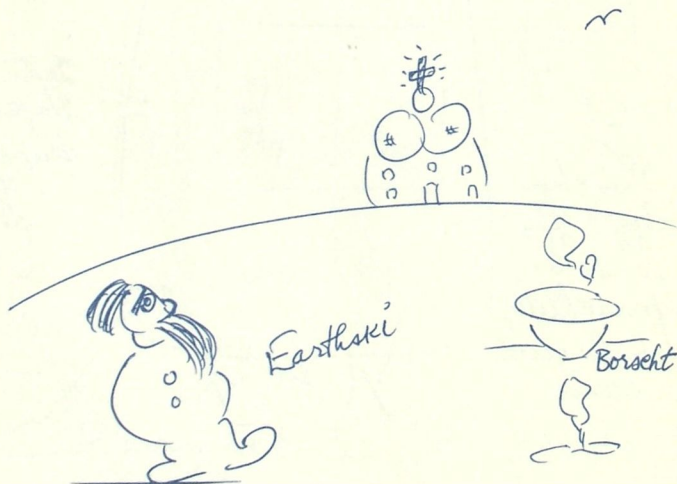
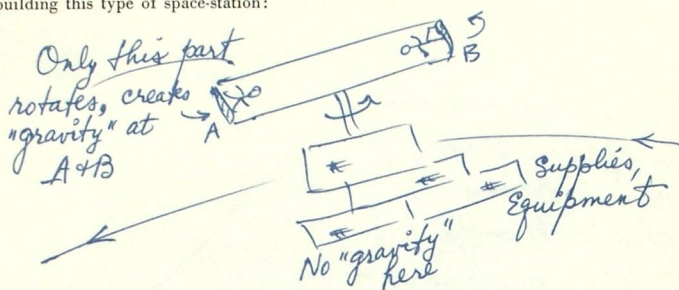




In the above case, the space-ship already has a speed of 5 miles per second, and only needs to be speeded up to 7 miles per second to nullify completely Earth's control.

What it amounts to is simply this: It is easier to carry 250 pounds of potatoes up a hill in 10 separate trips than if the entire sack be dragged up in one journey. (In fact, most Earth people could not do the job in one fell swoop.)

The Russian Earth-men have shown some interest in building this type of space-station:



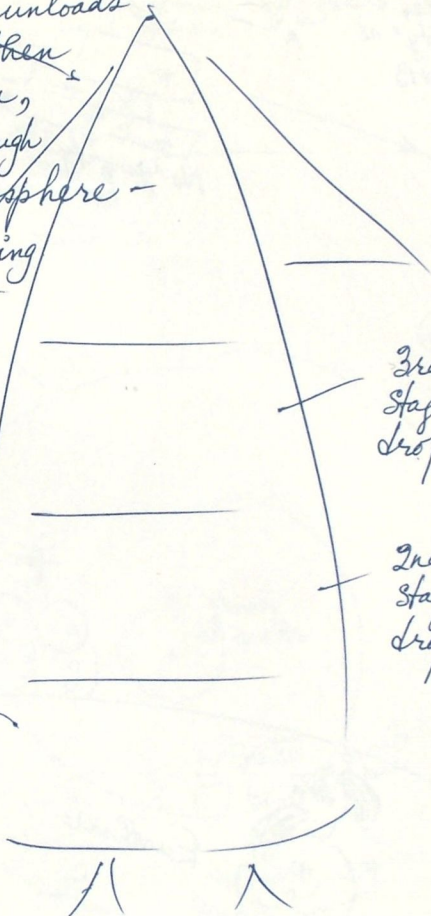
The rockets which will ferry supplies to the space-station will be built like this:

This stage unloads supplies, then can return, gliding through Earth's atmosphere - hence the wing surfaces

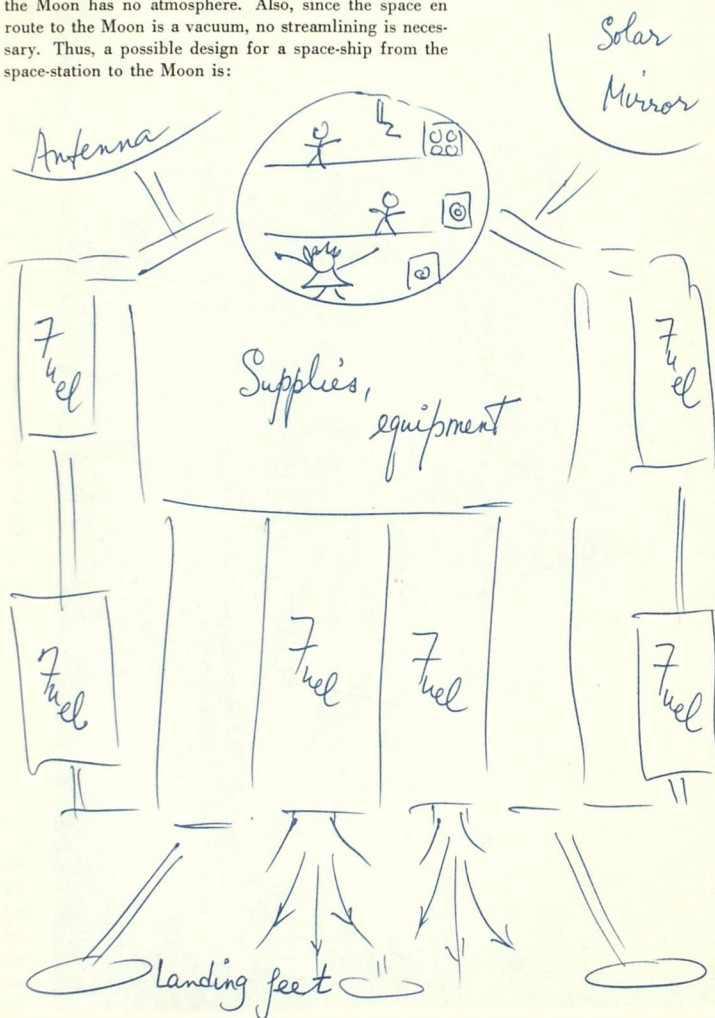
This stage drops off, lands by parachute, to be used again

3rd stage drops off

2nd stage drops off



A space-ship going to the Moon from the space-station might have any convenient structure, but needs no wings; the Moon has no atmosphere. Also, since the space en route to the Moon is a vacuum, no streamlining is necessary. Thus, a possible design for a space-ship from the space-station to the Moon is:



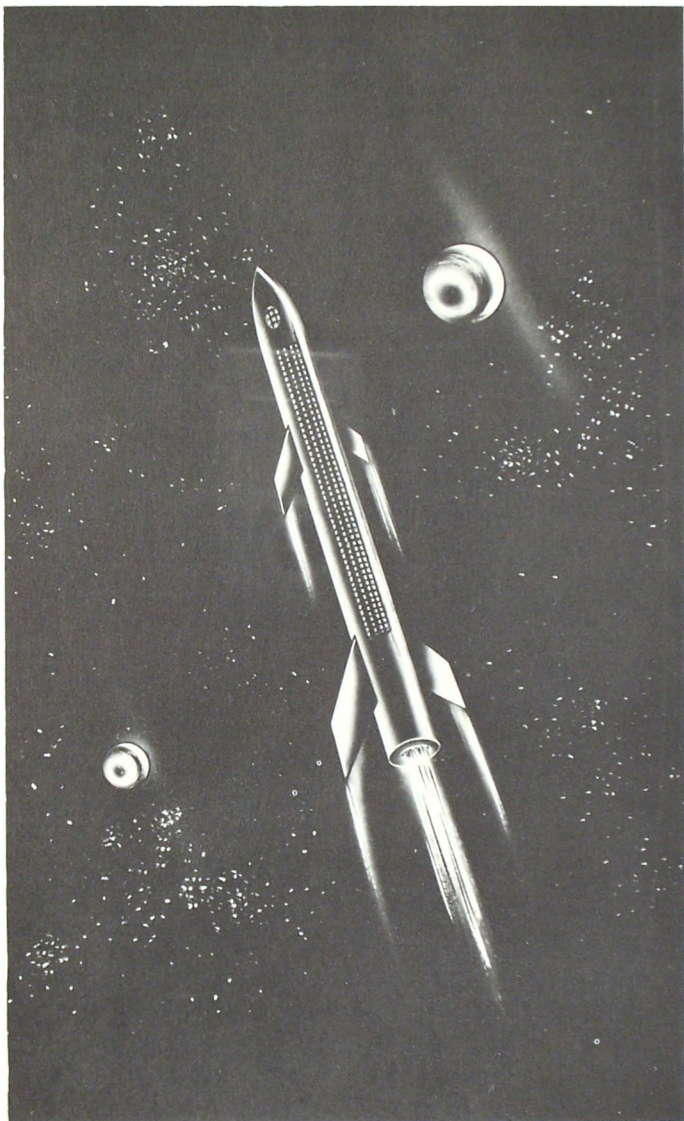
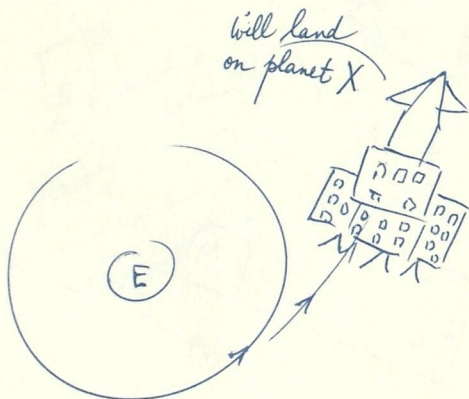


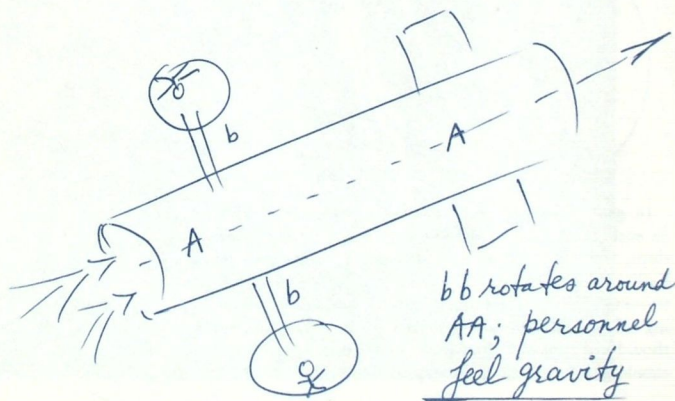
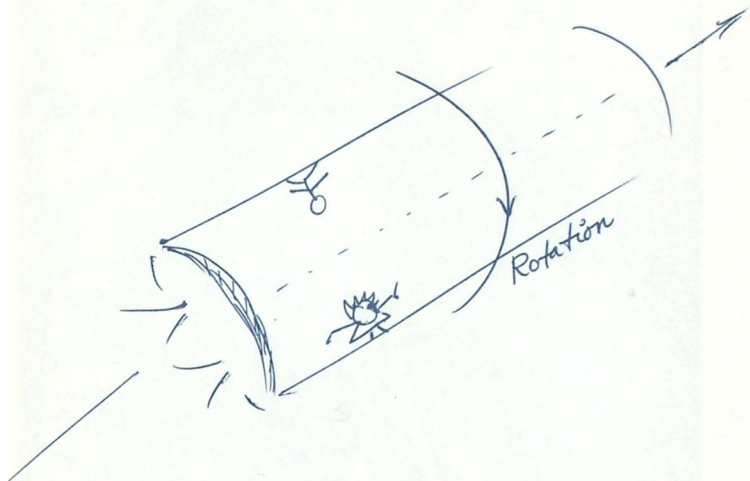
FIG. 1—A space-liner.

A space-ship traveling to a planet that has a substantial atmosphere could carry a glider unit if the travelers wanted to land only one portion of the ship.

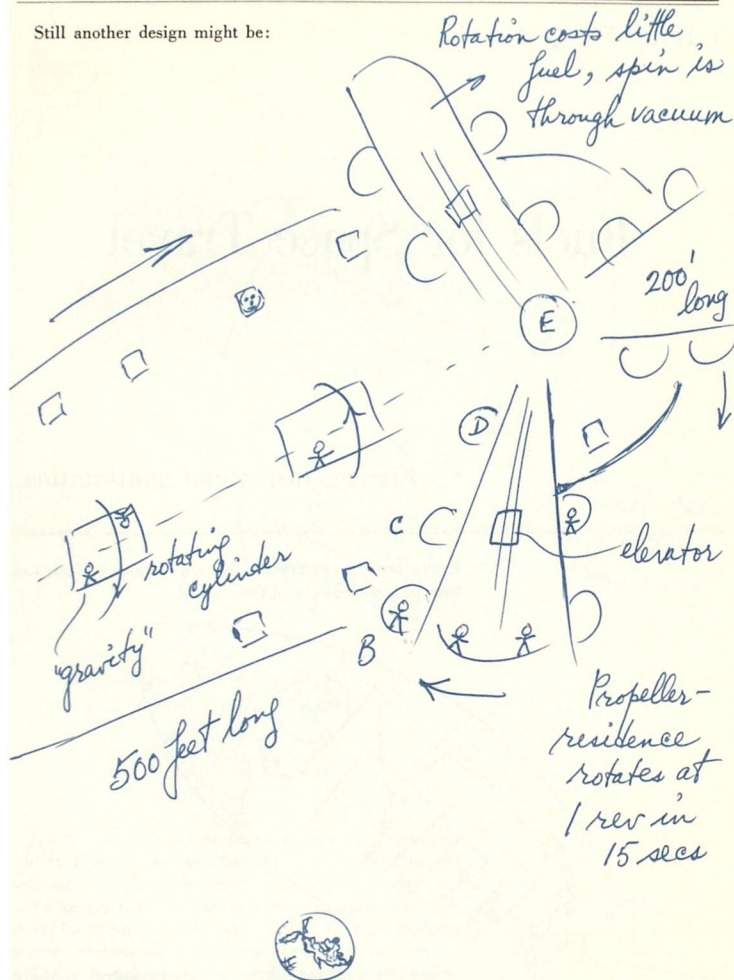


In general, *space-liners* are very elegant space-ships. As such, they are far more massive than ordinary space-ships, and would not land at all, *anywhere*, not even on Earth. In fact, they would be assembled at a space-station, travel to another planet and go into an orbit there, allowing only a small light unit to make a landing. Space-liners should not land on a planet any more than ocean liners should go up on land when they reach a port.

How will the space-travelers get along without gravity? They might be trained beforehand. But for long trips the condition of weightlessness may prove distressing. One attempt at a solution is that of lining the space-ship with steel and having the personnel wear magnet-soled shoes. A better solution is to rotate the entire space-ship, thus creating "gravity" at the surface by the throw-away effect.



Still another design might be:



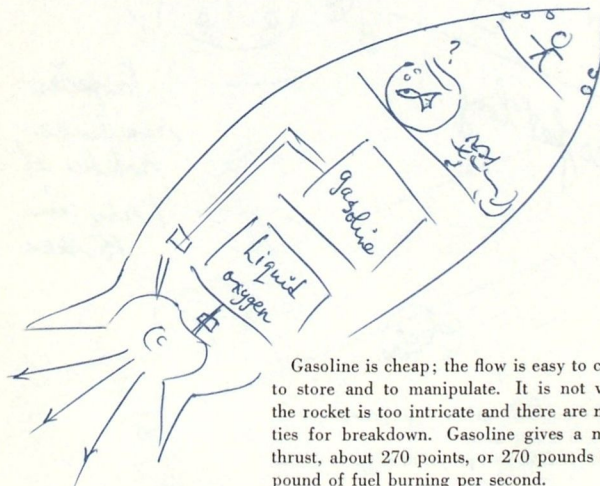
For propeller-residence, "gravity" is greatest at A, much less at D, and is zero at E.

And what kinds of fuels will propel these space-liners?

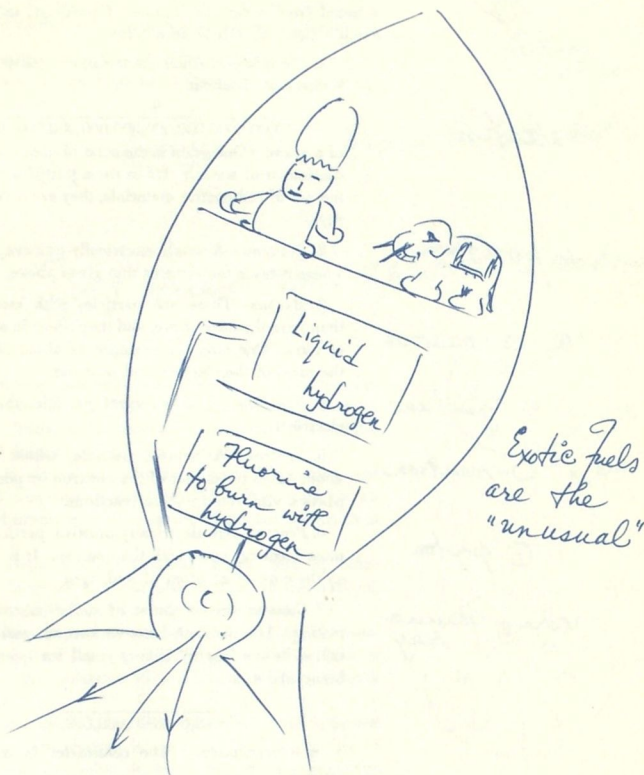
Fuels for Space Travel

Fission, fusion and annihilation.

EARTH-PEOPLE ARE FINDING that many kinds of fuels can help propel them out of their world.



Gasoline is cheap; the flow is easy to control, but hard to store and to manipulate. It is not very reliable, as the rocket is too intricate and there are many opportunities for breakdown. Gasoline gives a moderate to low thrust, about 270 points, or 270 pounds thrust from one pound of fuel burning per second.



Exotic fuel, such as that shown, gives greater speed, allowing a larger payload. But it is costly, poisonous and difficult to handle. The thrust is about 380 points.

To understand how fission and fusion space-ships will work, Earth-people study PARTICLES OF NUCLEAR PHYSICS, and the THEORY OF THE BOMBS AND ATOMIC ENGINES.

Today they know of 102 different elements. Everything in the world is made up of some of these in various combinations, simple or complicated. Thus, water is made of hydrogen and oxygen, but bread requires many more than two.



The 102 different elements, in turn, are actually constructed from a certain number of particles, in various combinations, as will be seen below.

1. *Electron*—A small electrically-negative particle whose mass is about

$$\frac{9}{10,000,000,000,000,000,000,000,000,000}$$

of a gram. (One gram is the mass of about one cubic centimeter of water.) When these particles come flying out of radioactive materials, they are called "beta rays."

2. *Positron*—A small electrically-positive particle, whose mass is the same as that given above.

3. *Mesons*—These are particles with more body than have the ones above, and they occur in a number of sizes. One size, for example, is about 200 times the mass of the electron and positron.

4. *Neutrino*—A tiny neutral particle, that is not electrical.

5. *Neutron*—A neutral particle, whose mass is about 1,836 times that of the electron or positron; it plays a vital role in chain reactions.

6. *Proton*—An electrically-positive particle of almost identical mass with the neutron. It is the same as the core of an atom of hydrogen.

7. *Gamma ray*—A burst of radiation, very penetrating. The distance between two successive peaks called "wave length" is very small for gamma rays, being about

$$\frac{1}{10,000,000,000,000}$$

of one centimeter. (The centimeter is this long: ———.)

Often, some of these particles stick together, as in the following combinations:

8. *Deuteron*—A neutron with a proton, the core of an ordinary hydrogen atom. The heavy hydrogen is called an "isotope," meaning "the same type" (that is, still hydrogen, though different in mass).

9. *Triton*—Two neutrons with a proton. This is called "triton," or the core of a very heavy hydrogen atom. (Tritium, therefore is also an isotope of hydrogen.)

- electron

+ positron

⊙ mesons

○ neutrino

○ neutron

⊕ proton

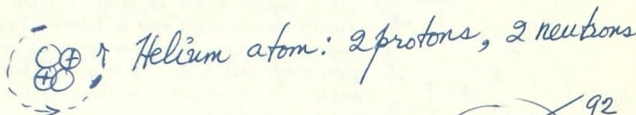
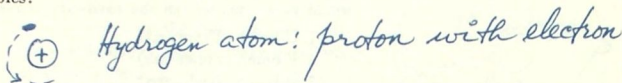
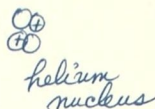
~ ~ ~ gamma ray

⊕⊙ deuteron

⊕⊕ triton

10. *Alpha particle*—Two protons and two neutrons. This is called an "alpha particle," and is the same as the core or nucleus of a helium atom.

As has been said, the 102 different elements are constructed out of combinations of these particles. Here are some examples:



To take some heavier atoms: If we have 92 protons and 146 neutrons (and 92 electrons), we then have an atom of uranium. Thus, a uranium atom contains 92 and 146, or 238 of those round units in its core.

There is also a uranium atom with 92 protons, but only 143 neutrons, a total of 235. This, then, is an *isotope* of uranium. (The number of external electrons is still 92.)

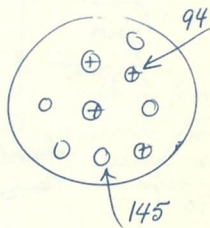
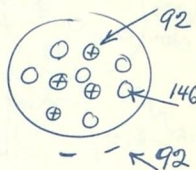
There are also other uranium atoms, that is, other isotopes; these all have 92 plus charges in the nucleus, but the number of neutrons can be different.

If one has 94 protons and 145 neutrons (and 94 electrons) one then has an atom of plutonium. Thus, a plutonium atom contains 94 and 145, or 239 round units in its core.

Therefore, atoms of different elements have different amounts of plus charges in their nuclei. The number of neutrons, on the other hand, does not determine the chemical character of an atom, but only determines whether the atoms are heavy or light.

The number of plus charges in the nucleus is called "atomic number." The total number of round particles (neutrons and protons) is called "atomic-mass number."

As it is often inconvenient to quote the weights of various atoms in tiny fractions of a gram, *relative weights* are used. The weight of an oxygen atom is taken as a base of comparison, and is said to be 16. The hydrogen atom is then 1.008 by comparison, helium is 4.003, lithium is 6.94, etc.



On this basis, the proton is 1.00758, and the neutron is 1.00894.

One may now consider the bomb process.

First of all, the uranium, plutonium, and hydrogen bombs should all be called "A-Bombs" or "Atomic Bombs." The designation "H-Bomb" is misleading. It would be correct to call the various A-Bombs:

1. U-Bomb (Uranium).
2. P-Bomb (Plutonium).
3. H-Bomb (Hydrogen).

Concerning the U-Bomb:

If a neutron strikes an atom of uranium-235, the uranium nucleus might split as follows: This "fission" fragment may have 36 plusses (protons) and 47 neutrons, which would make of it an atom of krypton; or it may have 56 plusses and 81 neutrons, which would make of it an atom of barium.

In 1905 the great Earth-scientist, Einstein, gave the formula for mass to energy conversion, or vice versa: $E=MC^2$, where C is the velocity of light (300,000,000 meters per second).

To get E in calories liberated one must write:

$$E = \frac{MC^2}{42,000,000}$$

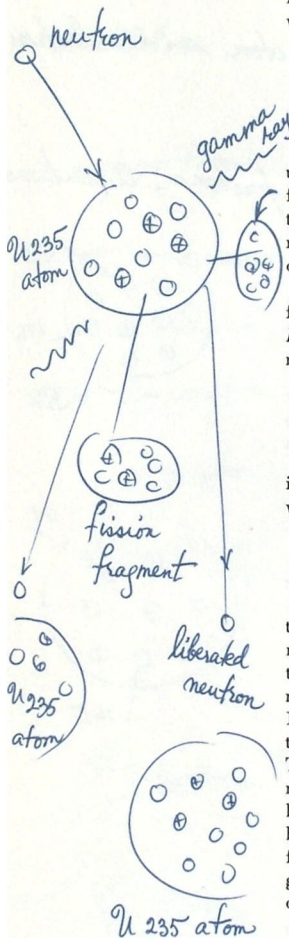
Thus, if after uranium is split, a shortage of 100 grams is observed, one knows that the following amount of heat was liberated:

$$E = \frac{100 \times (30,000,000,000)^2}{42,000,000}$$

Or: $E=2,150,000,000,000,000$ calories.

One notes that 36 protons and 56 protons add up to the original 92 protons of the uranium atom. But the number of round particles is now 36, 56, 47, and 81, or a total of 220. Now the original uranium atom had a mass number of 235. Therefore, one must account for about 15 units (16 if one counts the original bombarding neutron). In the sketch, two neutrons are flying away. There must be more. Actual experiment shows that less mass is found after the U-235 atom has been split than before; where is the missing little bit of mass? It has been converted to energy in the form of gamma rays and friction heat that the flying neutrons and fission fragments give us as they tear through the air or through the cement casing of the bomb or through anything else in their way.

Returning now to the sketch of the splitting uranium nucleus, what happens next? Obviously, the outward-



flying neutrons will strike other uranium nuclei, and in turn produce fission with a loss of some mass due to conversion to heat and gamma rays, and more neutrons, etc. This is the "chain reaction," which ends with a tremendous total liberation of heat and gamma rays (and flying fission fragments)—that is, the atomic bomb explosion.

The first neutrons which start all this may come from the following action, based on the fact that when particles which normally fly out of radium strike beryllium, neutrons fly out of the latter.

The problem of setting off the U-Bomb is therefore the problem of starting the chain by bringing, automatically, the uranium pieces and the initiating neutrons into proper positions.

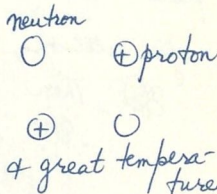
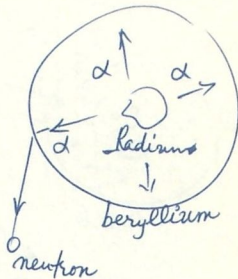
The plutonium bomb, or P-Bomb, follows the same principle. However, the plutonium fission occurs with more loss of mass, and therefore more energy is liberated as heat and gamma rays.

The hydrogen bomb, or H-Bomb, follows a sort of inverse process. Here, for example, four hydrogen particles come together, fuse ("fusion" instead of "fission"), and become a helium nucleus. But this helium nucleus has less mass than the fusing four hydrogen particles. Where, then, is the missing mass? It has converted into heat and gamma rays—a relatively large amount. In fact, one pound of fusing hydrogen yields seven times more energy than one pound of fissioning uranium. Why, then, do Earth-people speak of an H-Bomb as being 1,000 times more powerful than a U-Bomb? The answer is that *one can use a large amount of hydrogen in one bomb.*

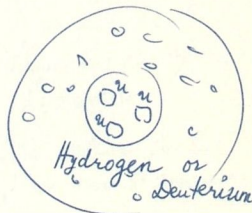
A uranium bomb has more limitation on its size. If there is little uranium present, the chain cannot become a runaway because of so much empty space, where neutrons miss; if there is a great deal of uranium, the chain runs away and gives an explosion without even using all the pieces. One can, therefore, use enough hydrogen to make a bomb possibly 10,000 times stronger than a U-Bomb.

Why was the H-Bomb not seriously considered some years ago, say *before* the uranium bombs? The answer is that to produce the fusion of hydrogen particles, a very high temperature is needed—perhaps ten million degrees. Such temperatures were not attainable until the U-Bombs were constructed. An H-Bomb, then, is built as follows:

A uranium bomb is made to go off in the center of a structure, while hydrogen waits on the outside. (In a sense, the U-Bomb is the match that "ignites" the H-Bomb.)



$\bigoplus$ A "fused" particle (helium nucleus)



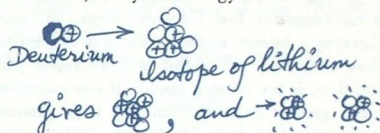
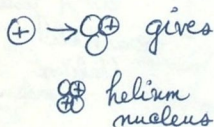
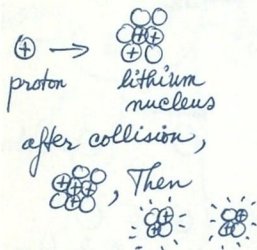
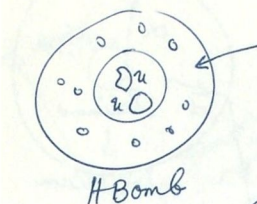
The four singles—2 protons and 2 neutrons—have a mass of about 4×1.008 , or 4.032, but the produced helium nucleus has a mass of 4.003. Therefore $4.032 - 4.003$ or .029 in mass has been lost. This has been converted to heat and gamma rays. It is a relatively large amount, compared to that yielded by U-fission mass conversion to energy.

Hydrogen is waiting, probably in some compound like lithium hydride. (Hydrogen alone as a gas would not be dense enough.) Even the lithium itself can convert to helium, giving up energy.

One could also have here deuterium, i.e., very heavy hydrogen to convert to helium.

Here is one way that lithium converts to helium. But these 2 helium nuclei add up in mass to less than the mass of the eight particles shown above them. The missing mass converts to radiant energy, gamma rays and friction heat.

Here is another lithium reaction which uses hydrogen, produces helium, and yields energy:



These two helium nuclei together have less mass than the eight particles shown above them, and the difference reveals itself as radiant energy, gamma rays, and friction heat (from the flying of the helium nuclei through air or through anything around them).

Finally, here is a very heavy hydrogen reaction: The helium nucleus has a mass which is less than the proton and tritium taken together, and the missing amount appears as energy.

In general, the heavier elements like uranium give energy when they are made to split or *fission*, and the lighter elements, like hydrogen, gives energy when they are made to come together or suffer *fusion*.

Elements in between would give less and less in their respective reactions, with some critical element—at transition region—giving nothing either way.

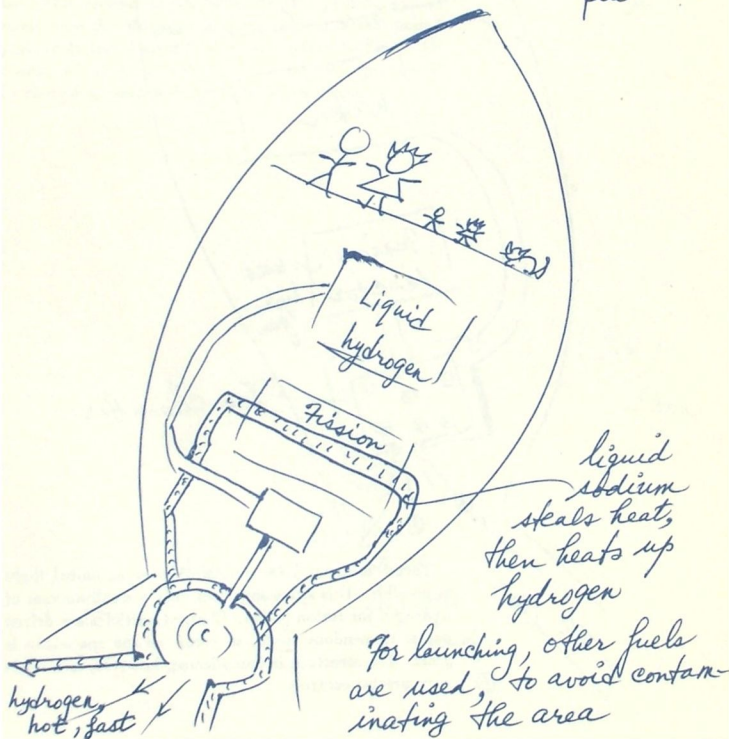
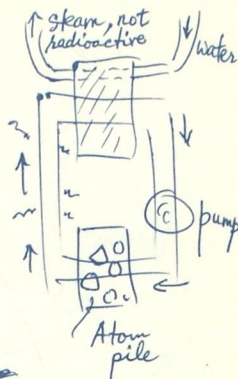
With regard to peaceful applications of atomic energy for power uses, one can say that uranium and plutonium can be so used. (Perhaps other materials are also used—secret ones.) One must arrange the uranium or plutonium pieces in a different manner—for one thing, further apart.

This arrangement is called an atomic pile. Then the chain does not run away, but becomes steady *trrrrr*, giving up heat which might be used to produce steam, and the steam to turn turbines and generate electricity.

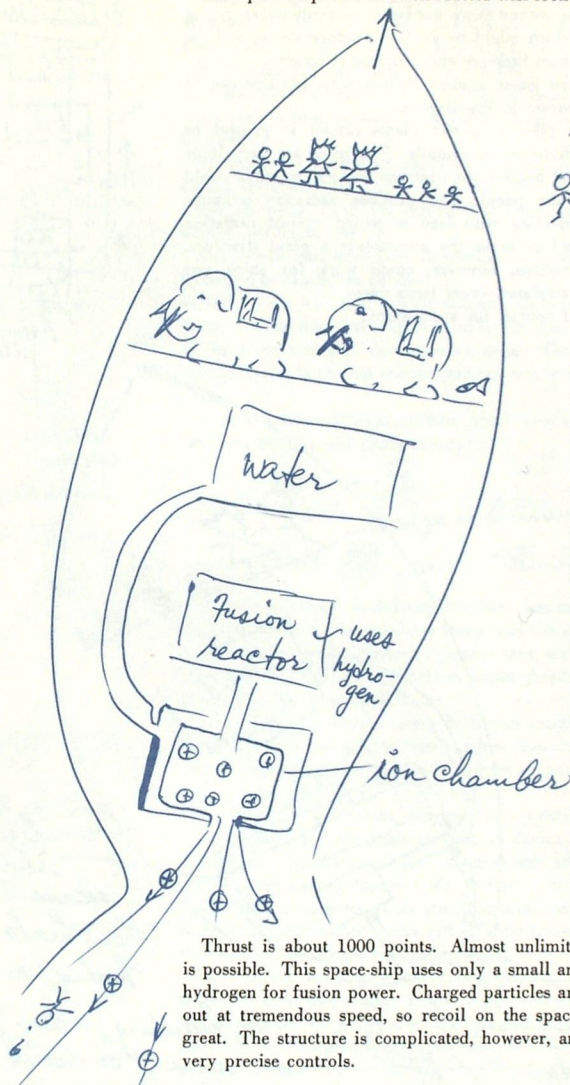
One must guard against radioactivity, but this can be done as shown in the diagram.

Atomic piles or power plants cannot at present be used to drive an automobile. The piles are very large in size, and besides, the neutrons and gamma rays would irradiate the people and produce radiation sickness. Heavy shielding with lead to guard against radiation would tend to make the automobile a giant structure. Atomic engines, however, could work for ships and even for airplanes—very large ones.

And, of course, for space-ships:



The space-ship with a fusion reactor will look like this:

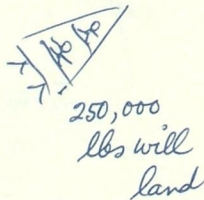
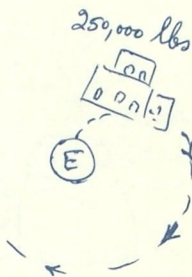


Thrust is about 1000 points. Almost unlimited flight is possible. This space-ship uses only a small amount of hydrogen for fusion power. Charged particles are driven out at tremendous speed, so recoil on the space-ship is great. The structure is complicated, however, and needs very precise controls.

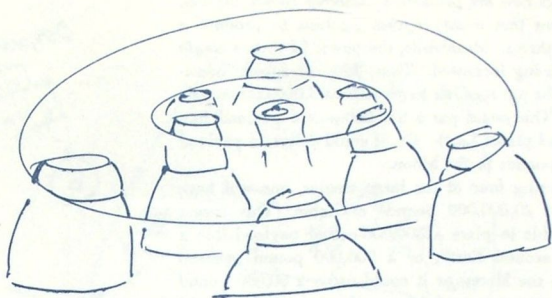
With the ion system, a thrust of more than 20,000 points could be attained. This means that one pound of substance used up in one second can give the space-ship a recoil thrust of 20,000 pounds.

Earthlings now are producing *clustered* rocket engines, which means that many engines combine to produce a very large thrust. Meanwhile, the power of even a *single* engine is being increased. Thus, four advanced "boosters" could be put together to give about 5,000,000 pounds of thrust. This could put a 250,000-pound payload into orbit around planet Earth. Or, it could deliver a payload of 50,000 pounds to the Moon.

By clustering four of the large singles, one will have a thrust of 20,000,000 pounds available. This rocket would be able to place a 300,000-pound payload into a low orbit around Earth, or a 200,000 pound payload safely onto the Moon, or it could cause a 50,000 pound payload to travel around Mars and return to Earth. Of course, all of these will carry considerable groups of Earth-men on safe and comfortable expeditions.



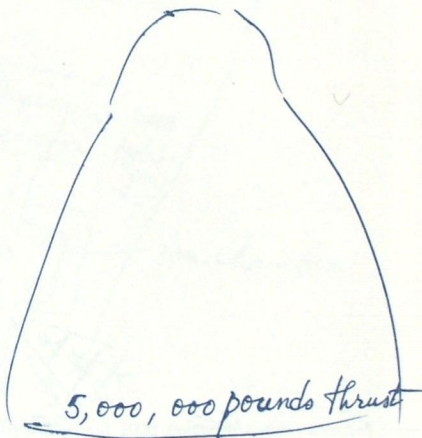
The cluster engines—of course an engine here is nothing more than a box where fuel burns and creates high speed gases which then escape, giving a back-kick as they depart—are arranged like this:



The large chemical engines look like this:

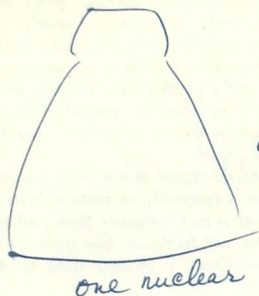


Atlas
360,000 lbs
with boosters



→
and 4 of these will be clustered

In turn, the nuclear engines will look like this:



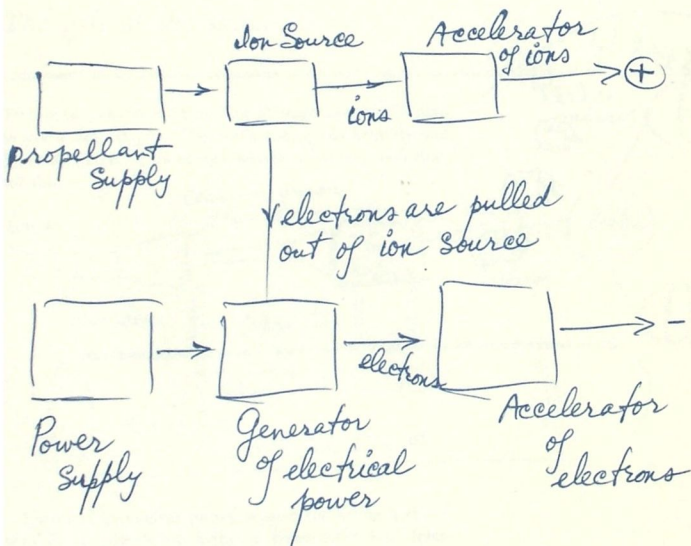
one nuclear

compare to



The large
chemical
ones

Now cluster 20 of the nuclear !!!

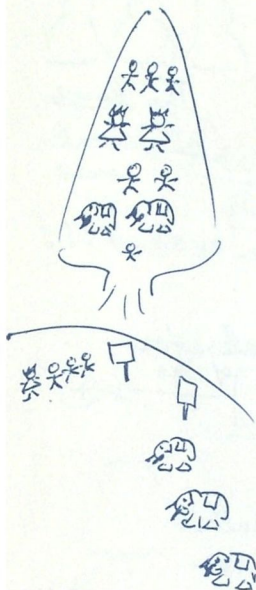


It is necessary to expel the electrons as well as the large positive ions, because that way the space-ship remains neutral electrically. If the electrons (which are light and give little thrust) were retained within the space-ship, they would soon, by attraction, make it impossible for further thrust-giving positive ions to escape.

For the production of the positive ions cesium is used. The cesium atom is easy to ionize by removal of an external electron, and is then easy to speed up to 400,000 miles per hour, or more.

The thrust of the cesium engine is not great, but the efficiency is high. Thus, a space-ship en route to Mars is lifted off Earth by chemical rocket engines, then, perhaps assisted by nuclear ones, and finally, in free space, away from the strong pull of Earth, is boosted along by the ion engines.

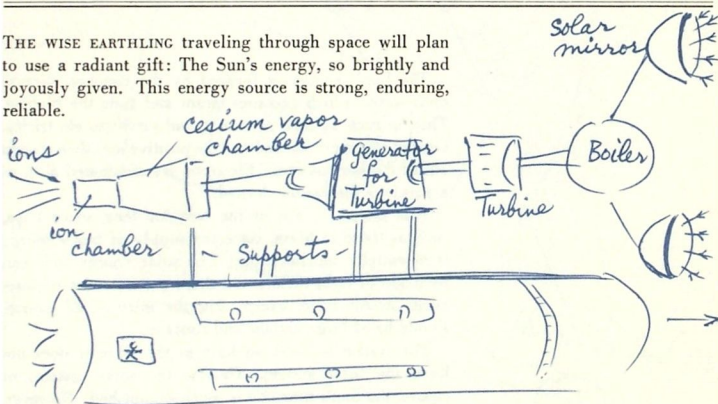
So the power is available—and the Earthlings are beginning to go out of their world.



Solar Energy

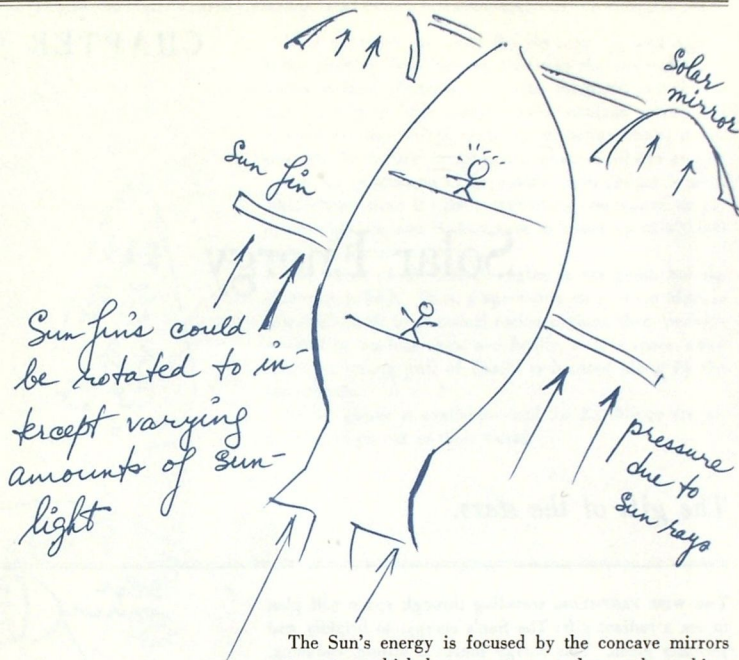
The gift of the stars.

THE WISE EARTHLING traveling through space will plan to use a radiant gift: The Sun's energy, so brightly and joyously given. This energy source is strong, enduring, reliable.



Chemical or nuclear power is used for lifting a spaceship off a planet—or firing it from orbit into interplanetary space.



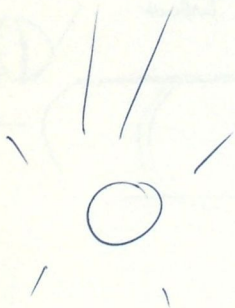


The Sun's energy is focused by the concave mirrors onto water, which becomes steam and runs the turbine. This, in turn, spins a generator and produces electricity. Cesium atoms are ionized and the positive ions then stream out of the ion chamber. Electrons are eliminated also, as a previous discussion showed.

This system is one of the best for long space trips, such as those to Mars, since the supply of Sun's energy is essentially inexhaustible. The solar energy unit can be made of light metals and there are no strict requirements as to shape, except that the mirrors, of course, should be of large surface and concave.

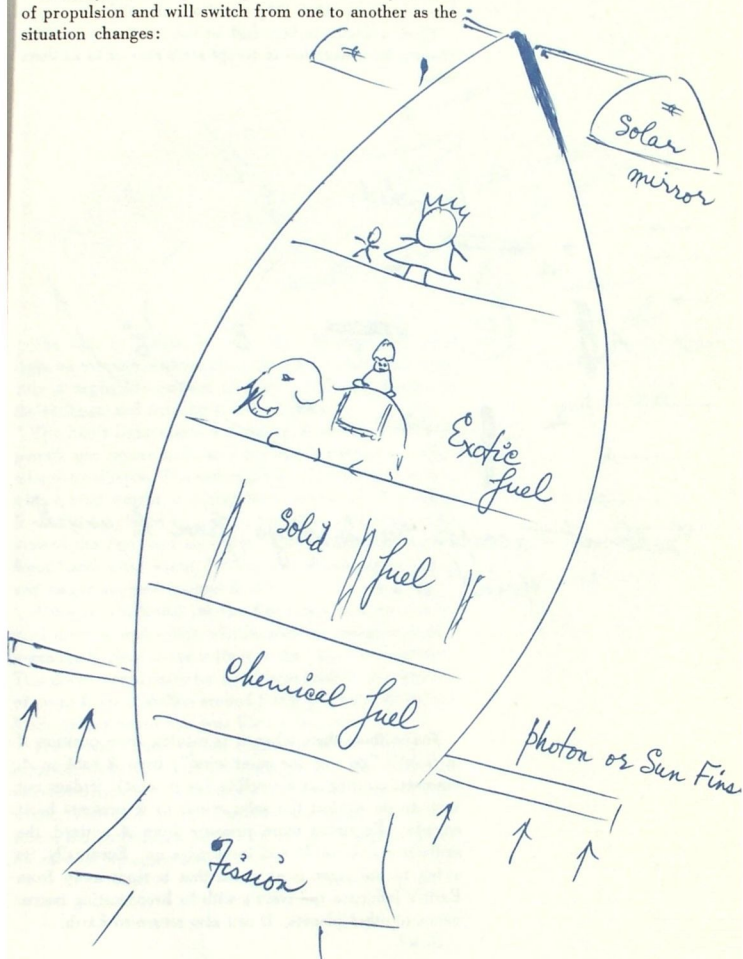
The system is good, so long as the traveler does not leave the solar system. Outside the solar system, of course, the Sun's intensity is much diminished. However, one can begin to "tune in" the energy of the new sun on approaching another solar system.

Sunlight falling upon an object presses upon the object; thus one could use the *pressure* of sunlight for propulsion through space, instead of converting the sunlight into heat to use for a turbine, etc.



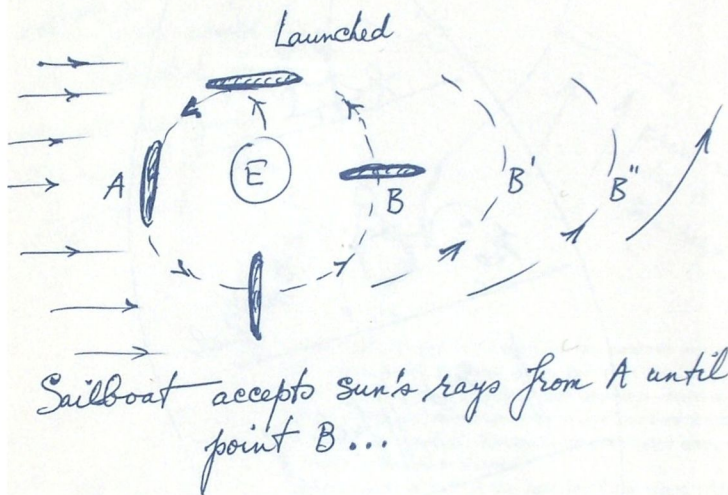
Of course the pressure is small, but if the surfaces are large and if the operation is in free space, the arrangement works very effectively—and "costs" nothing.

Actually, the best space-ship will combine many sources of propulsion and will switch from one to another as the situation changes:



The Sun's pressure may be used rather effectively in the assembly called "A Sailboat in Space." This is a slow-acting device of low power intended only to carry instruments and not Earth-people (who are always in a hurry to arrive when they travel anywhere).

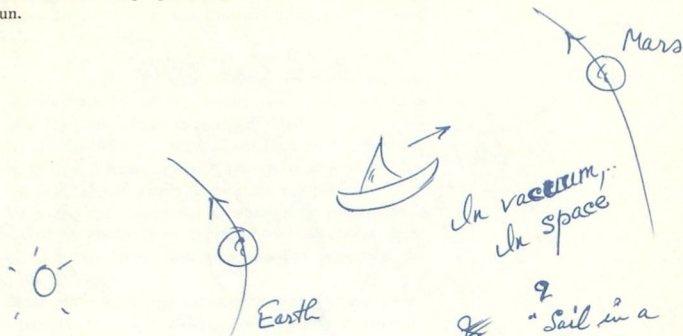
First, a device is launched in the usual way; it then changes its orientation to accept sun's rays or to let them miss . . .



The sailboat then, when it is moving from position A to B, will "go with the solar wind"; from B back to A, however, circling as a satellite (as it must), it does not want to go *against* the solar wind, so it presents itself edge-on. Receiving more pressure from A onward, the sailboat arrives at B' and turns edge on. Eventually, its swing to the right is so great that it tears away from Earth's influence and travels with its broadcasting instruments to other planets. It can also return to Earth.

How?

One can say, then, a sailboat can travel on the great ocean of vacuum, propelled by the silent "wind" of the Sun.



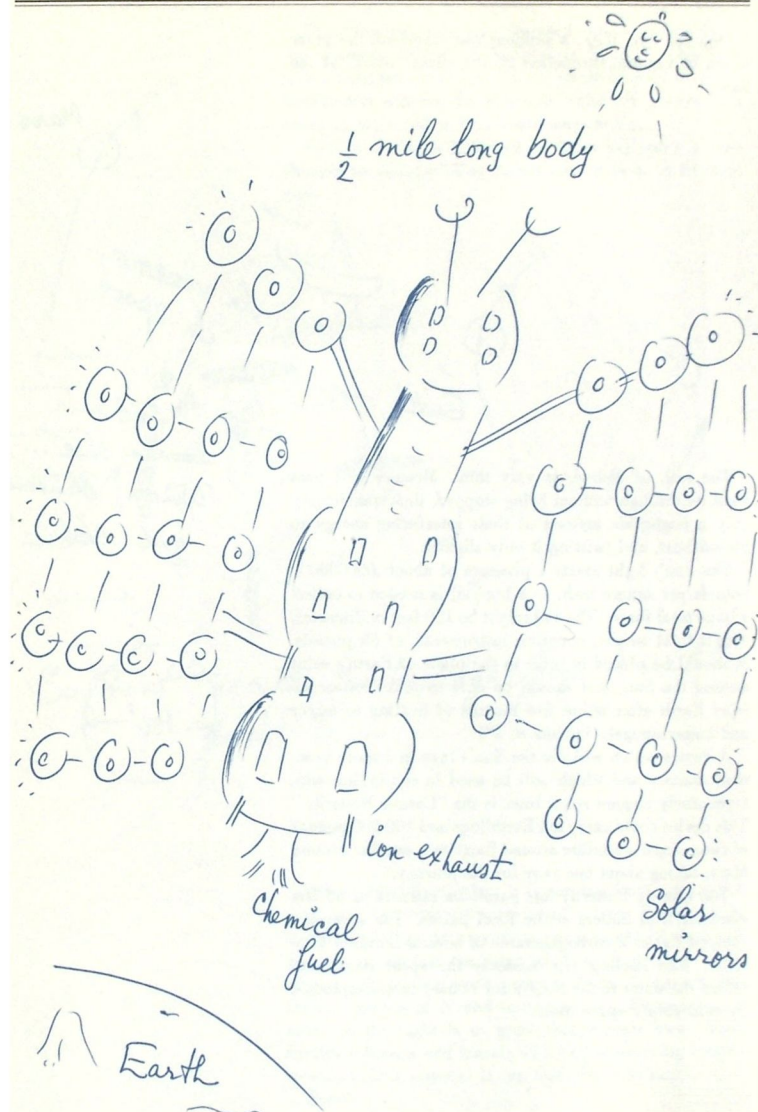
The sail, of course, is very thin. Meteors will pass right on through without being stopped, thus transferring only a negligible amount of their interfering energy to the sailboat, and twisting it only slightly.

The Sun's light exerts a pressure of about .000000009 pounds per square inch, so a big sail is needed to collect a large total force. The sail might be 150 feet in diameter, with a total weight, counting instruments, of 50 pounds. It should be placed in orbit in the plane of Earth's orbit around the Sun, and should be able to make its escape from Earth after about five months of orbiting to larger and larger apogees (points B , B').

A device which will use the Sun's rays in a more practical manner and which will be used in connection with a genuinely elegant space-liner is the "Cosmic Butterfly." This device could carry ten Earthlings and 100,000 pounds of cargo from a satellite around Earth to a satellite around Mars, taking about one year for the journey.

The Cosmic Butterfly has parabolic mirrors of 50 feet diameter with boilers at the focal points. The steam developed drives a turbogenerator of several hundred kilowatts. The cooling (to condense the spent steam and return the water to the boilers for re-use) is accomplished by cold empty space itself.





The generated current operates an ion rocket, where strong electrical fields accelerate cesium ions and expel them at tremendous speeds, thus giving propulsive recoil to the entire assembly.

The Cosmic Butterfly could receive solar energy—since it is freely available—through its entire journey, and thus, little by little, it could attain great speeds as it flits from one planet to another. Halfway to its goal, however, the Butterfly turns about, and its ion thrust is used to slow it down so that it can arrive at a proper low speed and “alight” safely in an orbit of a planet.

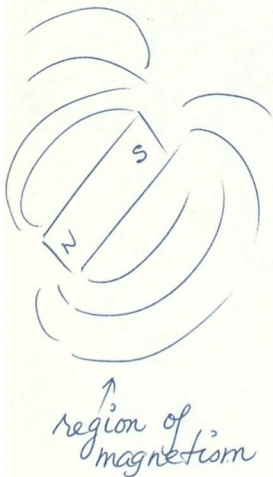
Of course the energy for its *heavy-duty* propulsion is supplied by chemical or nuclear fuel; the energy, however, that it imbibes from pure space is invaluable for the longer flights.

Much more energy is extractable from “pure space,” the great vacuum, as Earthlings are beginning to discover.



Energy from Space

Power from the ocean of vacuum.



ONCE UPON A TIME some Earthlings got together and invented the idea of an "atom."

"An atom doesn't really exist," these Earthlings said, "but it's a convenient invention. For example, gold is made of gold atoms, copper is made of copper atoms, iron of iron atoms. It's only a nice fiction, but helpful in chemistry."

But there came a day when a scientist announced, "You know those imaginary atoms—well, I just broke one."

So, Earthlings now have real atoms; those imagined ephemeral atoms really exist.

And they're running into the same sort of thing with another even more startling idea they invented: The vacuum.

"The vacuum," said Earthlings, "is nothing. You pump out the air, and then you have nothing—emptiness."

Now, however, it turns out that the vacuum has magnetism in it—some of it unchanging, like the magnetism of a bar magnet, but some of it varying like the magnetism produced when a current varies or when the sun erupts with an electrical storm.

In the vacuum of any region of space, Earthlings may find these electrical effects—electrical "fields"—some un-

changing, some varying. Electrical and magnetic fields travel through space—and vacuum—together, each giving rise to the other, in an unending cycle of death and regeneration.

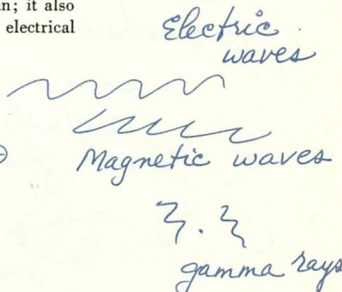
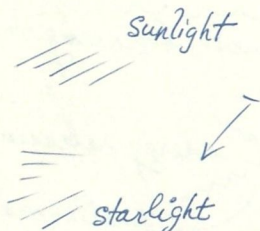
Electrical flow gives rise to magnetic field, and this, in turn, will give rise to an electrical effect.

Waves, traveling through space with the speed of light, can be plucked from the emptiness and formed into energy.

The electro-magnetic fields can come from the stars, from lightning on the planets Earth and Jupiter, and from the great turmoil of galaxies in collision.

Now, the people of Earth know that the electro-magnetic energy emitted in one second from a pair of galaxies in collision could supply all the energy needs of the planet Earth for one trillion years—if this energy could all be caught.

This vast vacuum also contains X rays from the sun, from other stars, and from the machines of man; it also has sunlight, starlight, and cosmic rays—tiny electrical particles and bursts of energy or gamma rays.



The Earth-scientist, Einstein, showed that *matter* itself can be converted into energy—into waves of electricity, magnetism, light, X rays, gamma rays—and thus can inhabit the vacuum, travel through it, and be plucked out of it, later, elsewhere, for use.

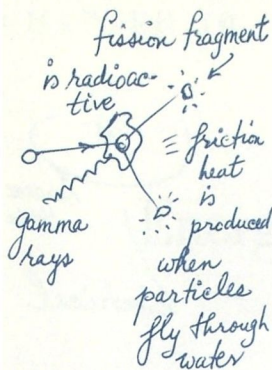
An Earthling, then, may pump the gross air matter out of a space, but that space will still have matter in it, nonetheless, matter in its wave form, impalpable to the touch and to the pump, but *there*, and extractable.

$$E = MC^2$$

wrote Einstein, *M* being the mass which is converted, *E* being the energy that appears in place of the mass, and *C* being the speed of light.

So, vacuum, *the nothing*, is vacuum, *the everything*.

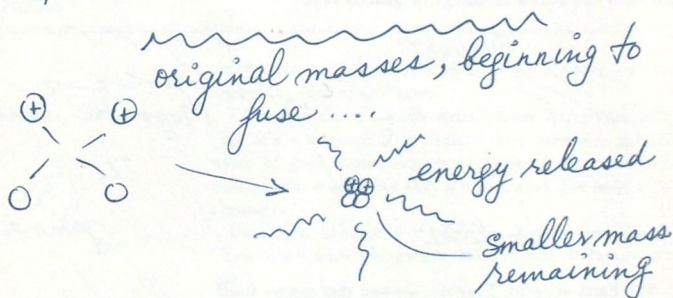




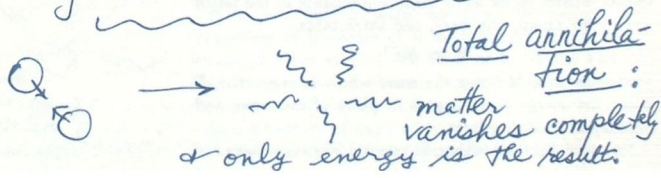
And now, Earth-man is beginning to understand that the "empty" space is alive and hopping with energy. Soon, he will learn how to extract great quantities of energy from the "nothing" for extended space-flights. And he will learn, too, how to send vast energies through the emptiness, not only as radio and television waves, but as potent waves, bringing great invisible power to the man-devices soaring through the heavens.

For the cases in which Earth-man will need very large amounts of power, he will transform matter which is merely concentrated or "frozen" energy—the matter of rocks, gases, liquids—into wave energy by the processes of fusion, or fission, or of total annihilation of substance.

Fission: partial annihilation of matter—
its conversion into gamma rays



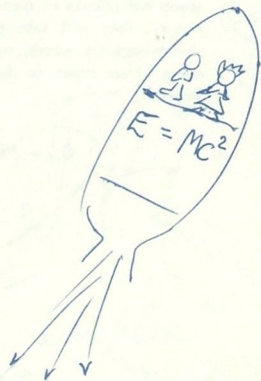
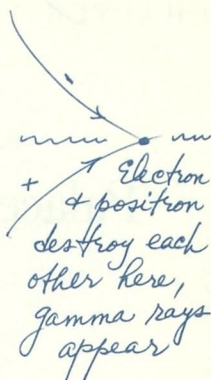
Fusion: partial annihilation
of matter...



In total annihilation, matter vanishes completely and only energy appears. (This is already practiced by Earth-man, though as yet, in small amounts.) Electrons and positrons annihilate each other, creating the pure energy of gamma rays.

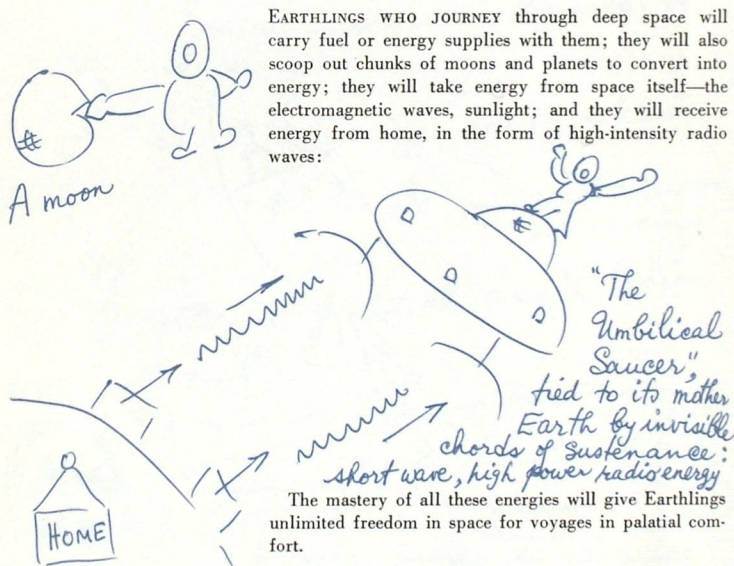
In some instances, particles larger than electrons and positrons can be made to annihilate themselves totally, thus giving rise to large amounts of energy.

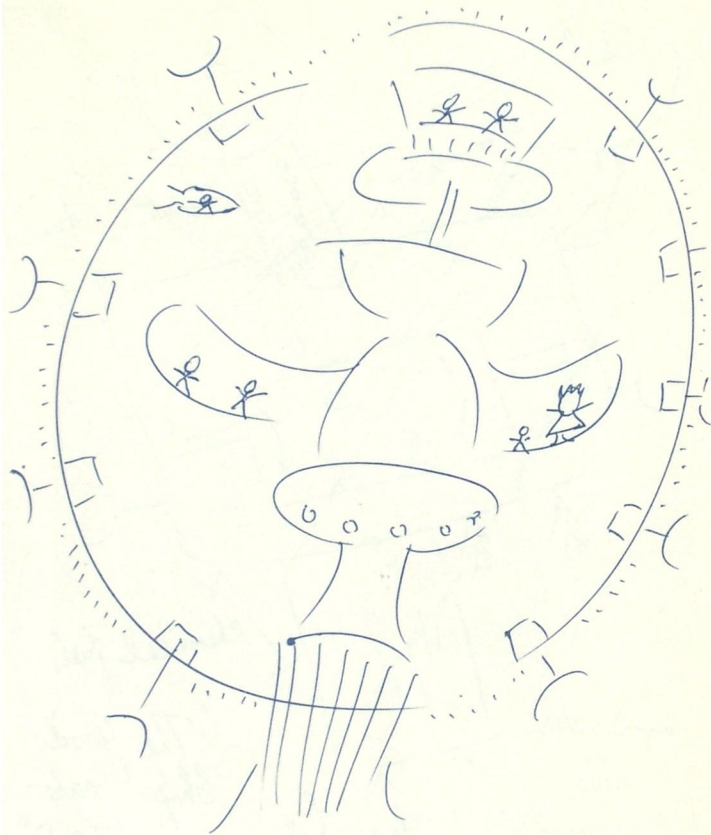
Earth-man, adventuring into space, will be able to pluck lumps of matter from moons and planets and convert these lumps to intense bursts of energy. Or, in mid-space, Earth-man requiring only supplemental quantities of energy will welcome the enduring sunlight and starlight, electromagnetic waves, cosmic rays and other founts of vigor inhabiting the nothing about him, as he sets his course for the stars.



Palaces in Cosmic Space

The Cosmic Cocoon, The Flying Turtle.

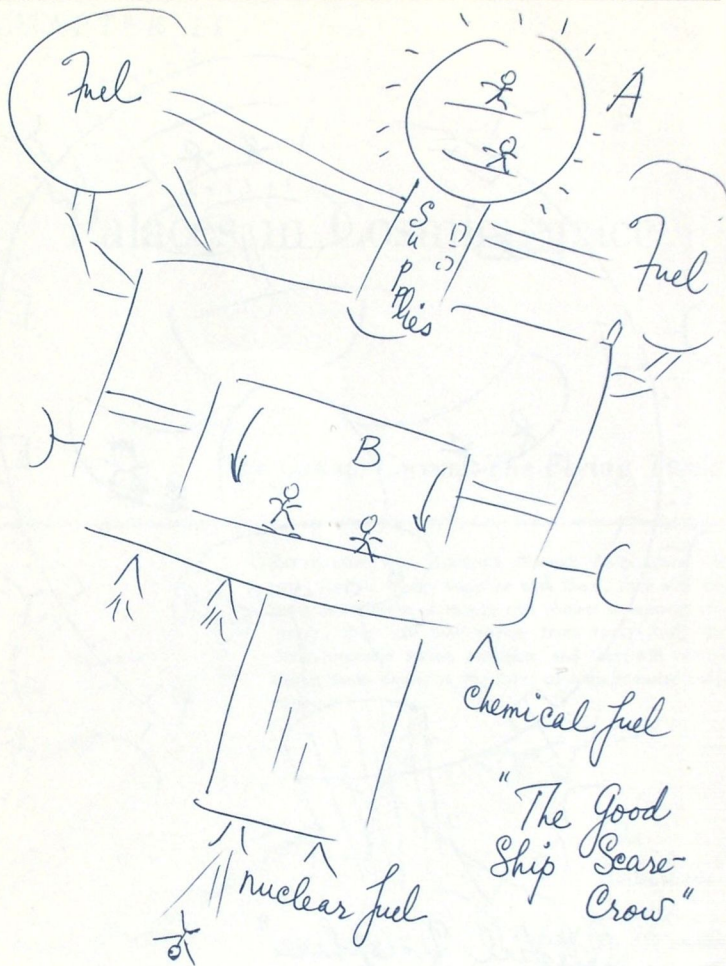




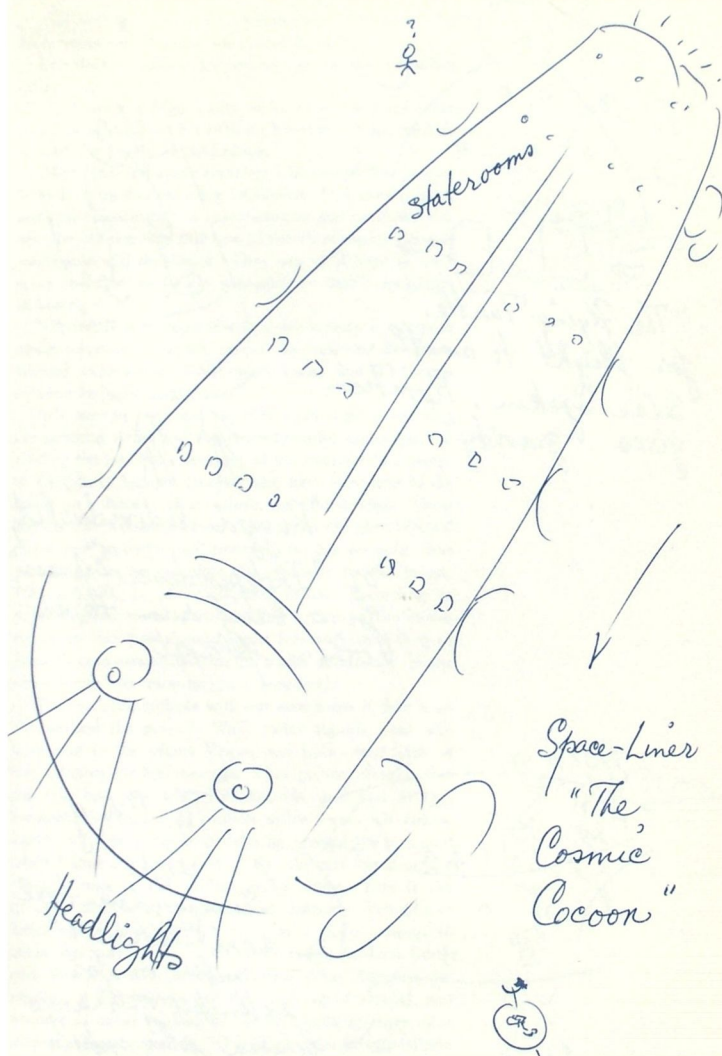
"Celestial Unisphere"

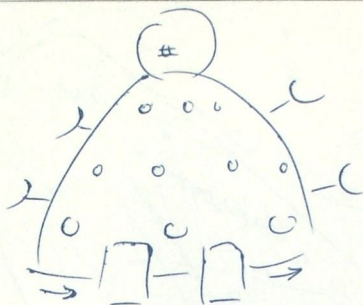
Main propulsion: nuclear energy;
 other - solar & electromagnetic
 from space



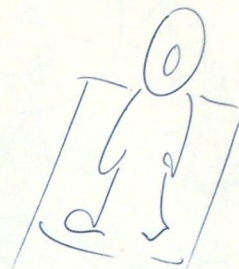


As the Space-ship accelerates, Earth-people in *A* and *B* feel gravity. When acceleration stops and the space-ship travels at constant velocity, then cylinder *B* is set rotating, and personnel who enter *B* will continue to feel gravity.





"The Flying Turtle"
for flight to another
Solar System. Rotation
gives "gravity"



"Rugged Individualist"
or "Independence Express,"
for a brief run to an-
other planet



"The City of
Light"
Energy from total
annihilation of
matter - for
extended journeys
between solar systems

And will it be easy to communicate with those who have remained at home on planet Earth?

Earthlings reassure themselves, as in the following estimate:

"Sometimes a Man wants to be alone, to have some quiet thoughts about his life—or his wife. Or maybe he's sick of the jangle of civilization.

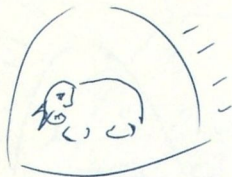
"Well, the first space travelers will escape that jangle. They'll be up there in a big fat *silence*. And, surprisingly, our space headshrinkers (psychologists and psychiatrists) are already warning that one of the chief hazards to our astronauts will be silence. They say we'll have to send some chit-chat up to our spacemen so they'll feel right at home.

"Obviously it is important that we develop a means of communication to reach across the vastness of space. Several experiments with radio, radar and TV transmission are now under way.

"It's easy to communicate with a satellite. Remember the orbiting Atlas and the two-way radio exchanges, including the satellite's beaming of the President's message to Earthlings below? Signals also have been sent to the moon on a number of occasions, the first in 1946. These signals traveled to the moon at the speed of light (186,000 miles per second) and returned in 2.4 seconds, thus permitting us to calculate the distance to the moon: $1.2 \times 186,000$, or about 223,000 miles. According to psychologists, when spacemen first arrive on the moon, *messages*—not just signals—must follow them, telling of Junior's cute escapades with the truant officer, etc. Home sweet home, wheresoever space may lead.

"Can we communicate with our astronauts if they wander beyond the moon? Well, radar signals have also been sent to the planet Venus, and have come back in five minutes, or 300 seconds. That means, clearly, that the trip one way took 150 seconds, and that at that moment Venus was 27 million miles away. Of course Earth and Venus are both orbiting around the sun, and when Venus is on one side of the sun and Earth on the other, Venus is 159 million miles away. This is the greatest distance that can exist between Venus and Earth. How long would it take for a radio message to travel one way? In a radio conversation between Earth and Venus, would there be a time delay between the sending of the message and the receiving of a reply, and would this cause confusion? If an Earthling rings up a man on Venus when it is 159 million miles away and asks



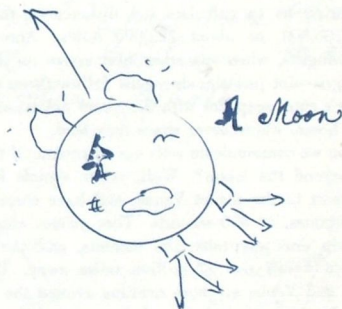


him a question, the soonest he could expect a reply to reach him would be about 28 minutes later. (This might present a problem when the operator says, 'Your three minutes are up.')

"The radio signals bounced off Venus were not true messages, and could not be easily recognized for a couple of reasons. In the first place, Venus has an atmosphere, complete with electrical disturbances (lightning). This lightning generates electrical and radiolike waves which travel through space and reach Earth along with our bounced waves. Furthermore, a great many other bodies and regions in space generate and radiate electrical waves. These, too, reach Earth, so more radio 'noise' clutters up our bounced signal from Venus.

"The secret of better communications to Venus and beyond is more power and more distinctive coding. Once we have developed these, we will be able to reach Earthlings on Venus with pacifying news of the routine mayhem on the home front."

People of Earth are, clearly, preparing to travel—but they plan to remain in touch with their native planet. Earthlings, evidently, are sentimentalists and subscribe to the principle, "Be It Ever So Humble, There's No Earth Like Your Own."



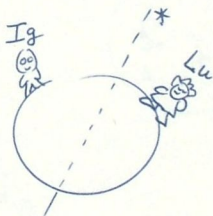
"Moon Transfer" -
A Moon propelled out
of orbit

Heavenly Travel

Constellations. Guiding a space-ship.



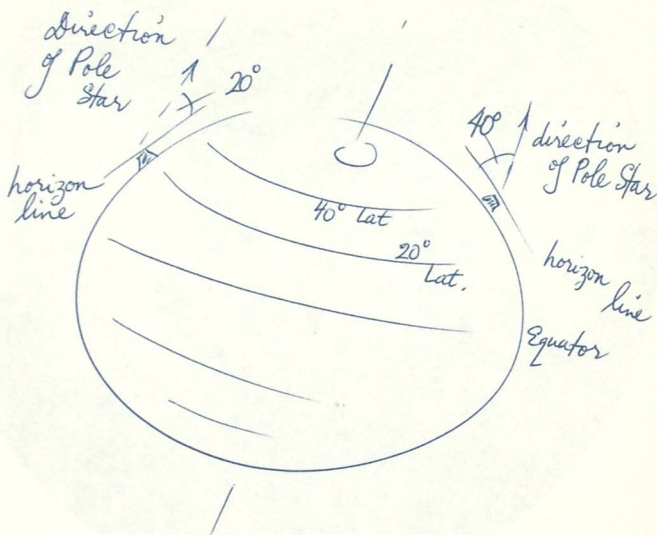
THE STARS ARE LIGHTHOUSES of the sky, winking directions to adventuring spacemen. Poets in many lands of the planet Earth speak of "a star conversing with a star." For centuries, these conversationalists have guided uncertain but daring Earth-men over the surface of their planet. Soon they will point the way for journeys across the ocean of space.



The North Star is a beacon. The axis of the Earth—its northern end—points to this star, giving Earth-men a point of reference. An Eskimo living at the geographic North Pole has the North Star always over his head. (The Eskimo living at the geographic South Pole has no such star.)

An Earth-man at any place in the Northern Hemisphere can tell just exactly where he is by observing the North Star. The angle between the horizon line and the direction of the North Star is called, "the altitude of the Pole Star."

Any Earthling, then, can see that the altitude of the pole is the same angle as the latitude of his location.



Soon, Earthlings will have artificial "stars" to guide them—like the satellite orbiting 22,300 miles from the surface of Earth. As the satellite travels from *A* to *B* (at 7000 miles per hour), the Earth rotates, and *C* occupies position *D*.

The object *A* could be luminous, shiny, twinkly—like a star—and an Earth-man in space would know his whereabouts, by observing the position of *A*.

Of course the groups of familiar stars—the constellations—are all beacons for Earth people who study the heavens. Here are some views of a part of the Universe as seen from Earth:

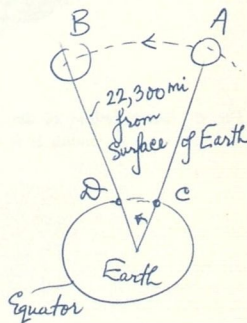




FIG. 2—Constellations of the Northern Hemisphere. (Hold chart so that the appropriate month is at the bottom and face north about 8 P.M.)

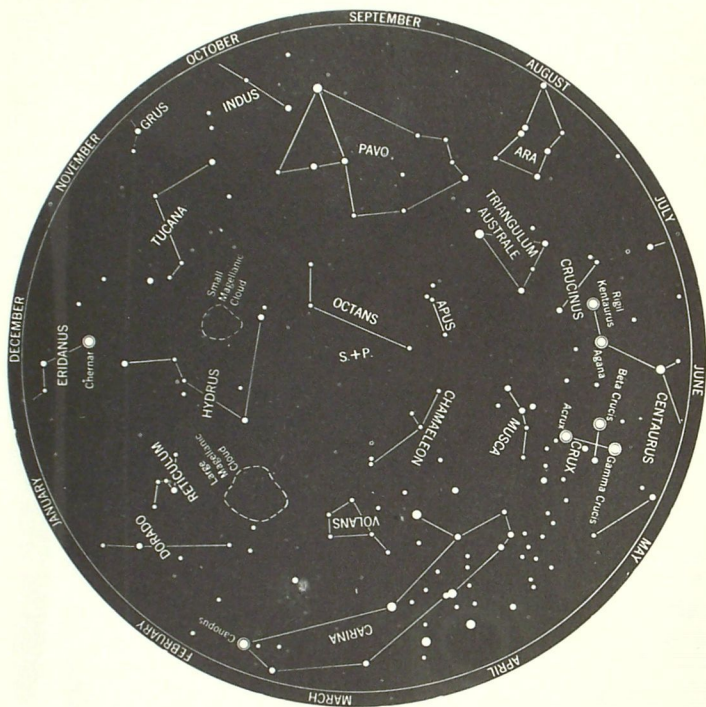
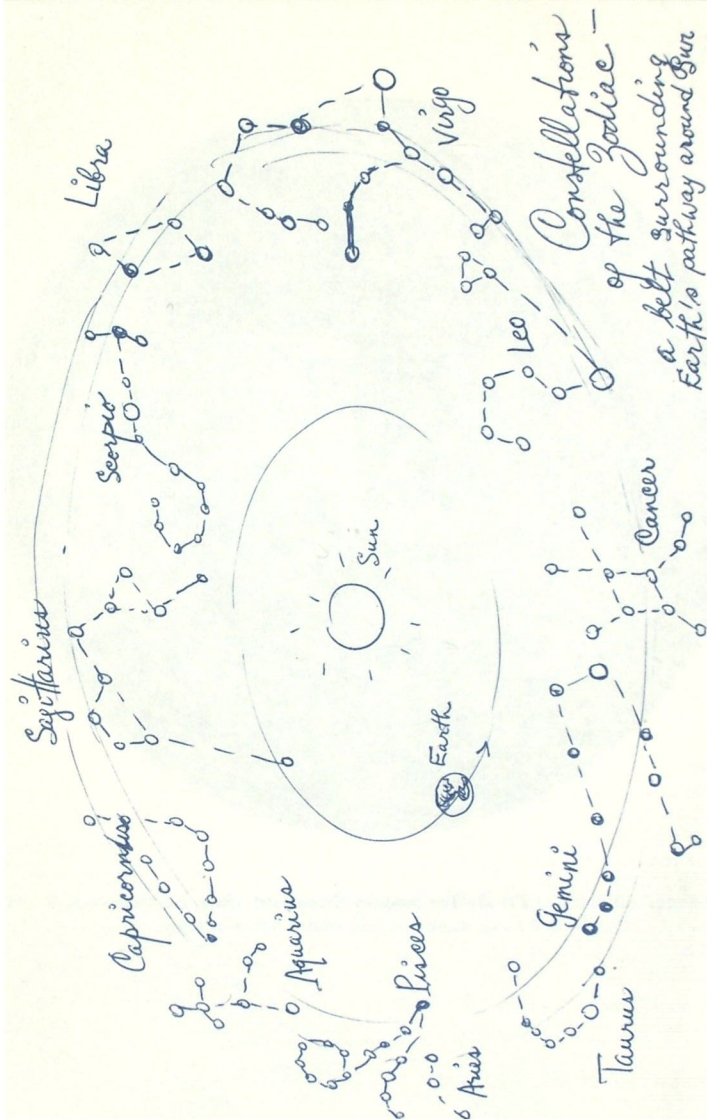


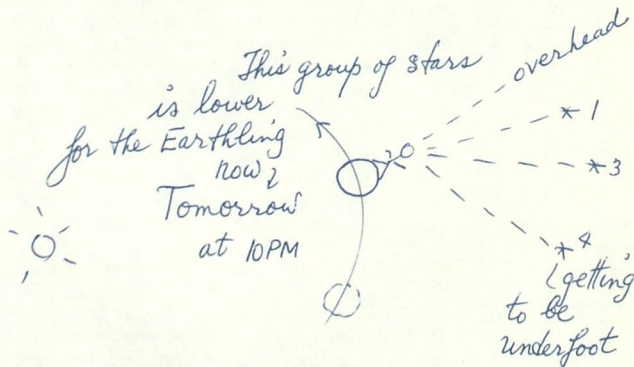
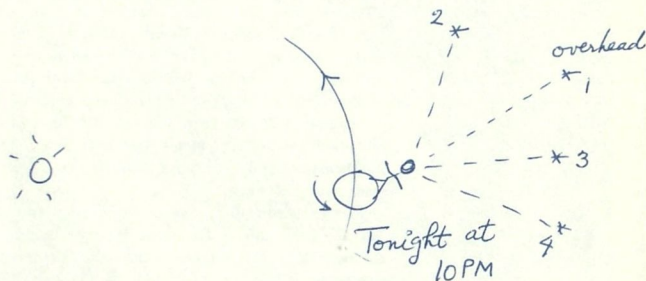
FIG. 3—The southern circumpolar stars.

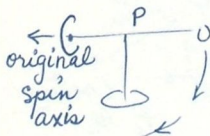
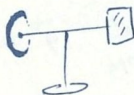
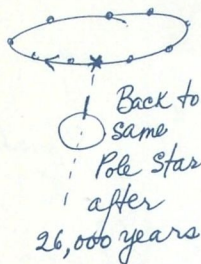
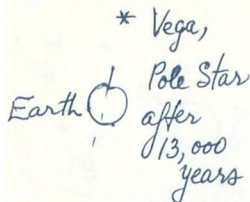


If the Earth did not travel around the sun, but simply rotated in space, a view of the sky at any given time on a certain night would be exactly the same as the view of the sky at that same time on any other night. (Of course, if the Earth did not travel around the sun, it would fall into the sun!)

Because of Earth's travel around the sun, a man standing on Earth will see constantly varying aspects of the heavens. Suppose he looks at the heavens at a certain time one night and the following night, he looks again. The aspect will have changed.

If, however, the man had looked at the sky about four minutes earlier on the second night, it would have looked the same. He, with Earth, would have rotated a little bit less.





If *two* days go past—48 hours—the heavens then would appear the same if the man looked *eight* minutes earlier. If 15 days go past, he should look 60 minutes earlier; if 30 days go past, he should look 120 minutes earlier.

About 90 constellations are officially recognized by Earthlings, and their apparent motions—as the Earth rotates and also travels around the sun—afford the Earthlings much pleasure, and guidance as well.

Star positions for views from various latitudes and for different times of night and different days of the year are well-known. (These are recorded in large impressive books, for use by strong and scholarly navigators.) Men have long used this starry knowledge to find their way over the oceans of Earth, and soon this same knowledge—and more—will light their way through the oceans of space.

As the planet Earth travels around the Sun, year after year, the Sun and the Moon pull upon the bulge of Earth's stomach and impart a slow variation in the tilt of Earth's axis. In one year, the tilt hardly shows, but in thousands of years it becomes very evident. During the course of 26,000 years the axis will have pointed to all possible directions along the circle that it traces in the heavens, and will have returned to point to the same Pole Star again.

This slow conical motion of the Earth's axis is called "precession," and is the same type of motion that a spinning top demonstrates (although for the top the precession is much more rapid). In the case of the top, it is gravity that exerts the external pull; in the case of the Earth, we recall, it is the Sun and the Moon.

Precessional motion is a little surprising to Earthlings because in their daily lives they have only sporadic experience with behavior of bodies which are rotating and which may become disturbed by an external force. Rotational effects, many Earthlings are finding, can be startling, entertaining and fascinating. Below are a few examples.

A wheel and a weight are in balance. If the wheel is made to rotate, the two weights are still in balance, and nothing more happens. Now, if an additional weight is added to one side, the cross-piece, instead of yielding to this excess weight and sinking, begins to *rotate* in the horizontal plane.

The explanation goes like this: The rotating wheel had an axis *ab* about which it was spinning. The addition of weight *c* tended to give the entire crosspiece, including the wheel, another rotation, with an axis which is perpendicular to the plane of the paper at the point *P*.

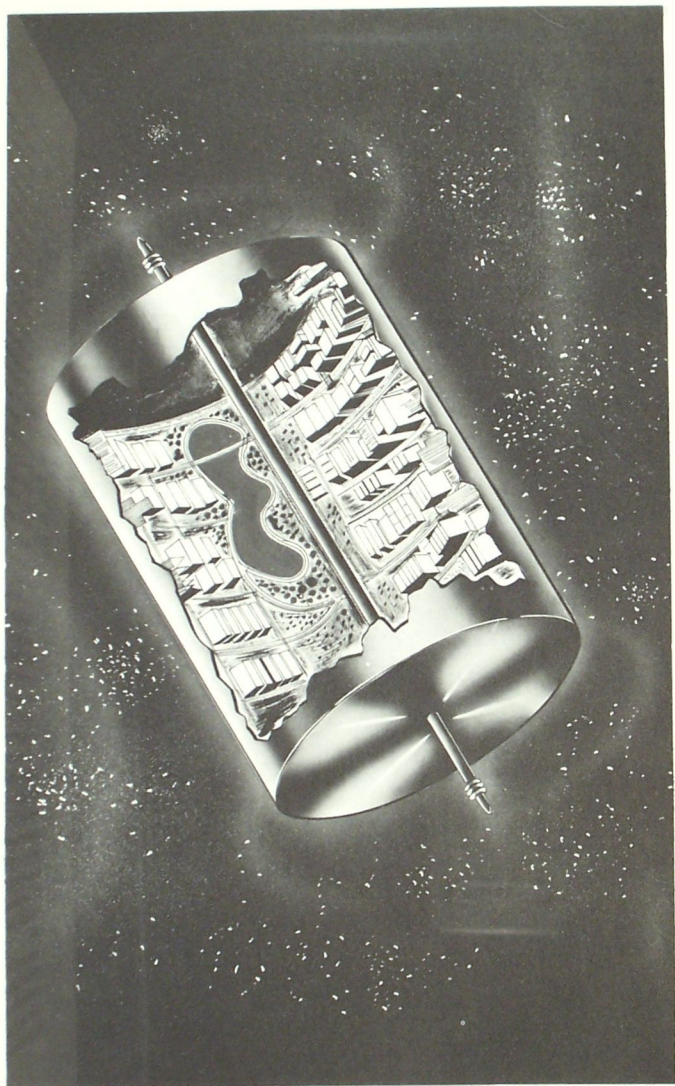


FIG. 4—Noah's Ark of space.

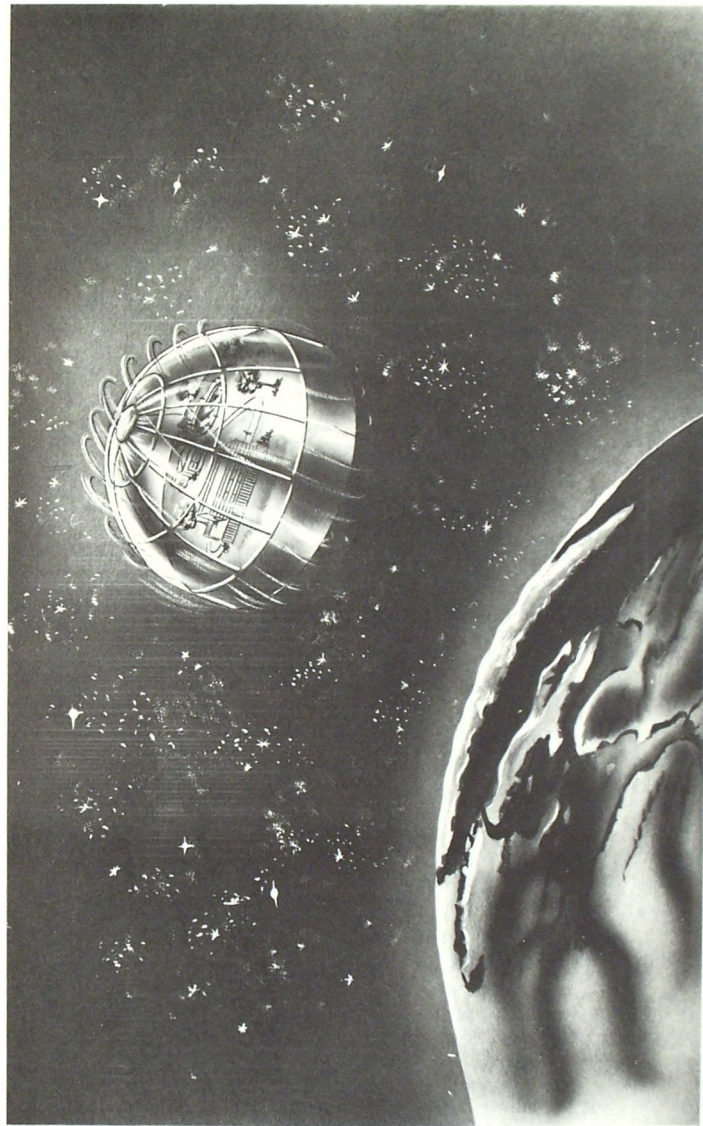


FIG. 5—A flying estate.

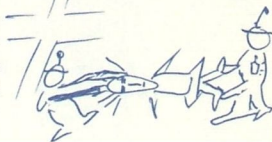
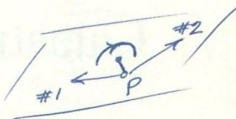
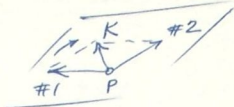
The wheel now has *two* axes vying with each other, and, being anxious to please all around, it decides on compromise and accepts an intermediate axis of rotation, *PK*. As a result, the wheel assumes its new position—hence its axis has rotated in the horizontal plane, while the wheel itself continues to spin as before. The turning of the axis endures so long as the wheel spins. This is, of course, “gyroscopic motion,” here called precession.

In problems of guidance for space-ships, Earth-people make use of this same principle. A wheel is made to rotate (by a motor, continuously). So long as the space-ship travels in the direction along the axis, all goes smoothly. However, if the space-ship should veer from its course, an additional axis of rotation would begin to impose itself upon the wheel, and it would move to a compromise position, as before. But! In moving to this position, the axis (here the axle) would activate some electrical controls which would “correct” the situation by bringing the wheel back to its original direction, thus pointing the space-liner as it was originally directed. So Earthlings, by using this principle of precessional motion, have discovered how to set a course to the stars and to maintain that course by automatic devices.

Another principle of value in space flight is discernible in the following situation: A weight hangs on a spring. If the space-liner is traveling at a constant velocity, the weight maintains a fixed position. If, however, the space-liner *accelerates*, the weight lags behind and the spring extends (because the weight “weighs more”), making the pointer come down to *B*. Note now that the pointer, in coming down to *B*, could activate some control which would reduce the fuel flow to the combustion chamber (or even shut it off), thus *reducing* the speed of the space-liner, and restoring it to its original value. (If one does not wish to retain constant speed, of course, the fuel controls are disconnected from the pointer mechanism.) This weight and spring gadget is called an “inertial” device.

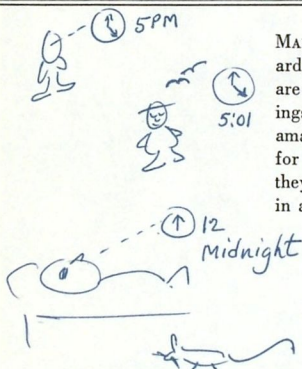
Thus, the gyroscope can help keep the space-liner on course, and the inertial device can help regulate its speed—all, automatically.

Magnetic compasses remain useful, it must be conceded, for such undertakings as mapping the magnetic field of the planet Earth, and for enabling Earth Boy Scouts to help reorient distressed old ladies who have become lost in the wilds, or to assist other distressed old ladies in the project of crossing the streets.

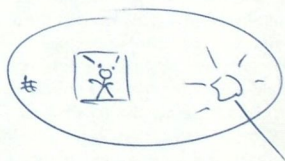


Catastrophe in Space

Or survival. What shall we do?



MANY EARTHLINGS stay awake nights worrying over hazards that may stalk them in space. Some of the worriers are professionals, and get paid for having insecure feelings eight hours a day. Many more are lay-worriers, amateurs who worry "round the clock" and are not paid for their anxiety. It is a sort of hobby with them, and they seem to live better and more rounded lives while in a constant ferment.



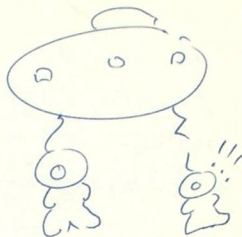
"It is true that a space-ship may be struck by a large meteor and the expedition may founder," the professional worriers admit, "but it is also true that this is a very remote possibility. If a meteor is large enough to cause disaster in space, it will probably be large enough to survive burning in the atmosphere, and will reach Earth to smash something there."

Not long ago Mrs. Hodges was lying on a bed when a meteor struck her in Alabama. The meteor from outer space had entered her house through the roof and assailed her without warning.

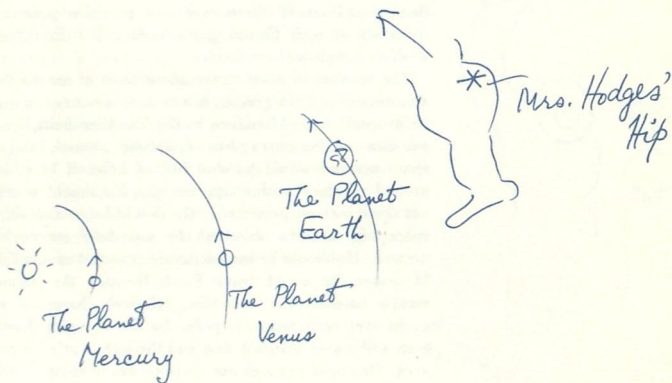
This is an extremely unlikely event.

"But it happened," says Mrs. Hodges rightly.

Even so, it was truly a rare coincidence. Consider the facts: Mrs. Hodges' Hip was traveling through space (with Mrs. Hodges attached, of course) without a worry in the world, on the planet Earth, at 67,000 miles per hour, around the Sun.



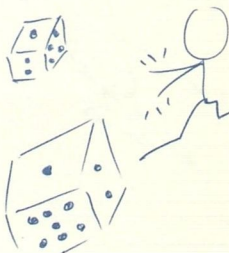
A meteor
← B



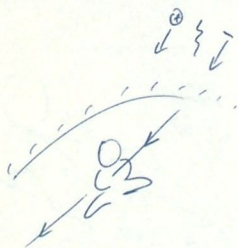
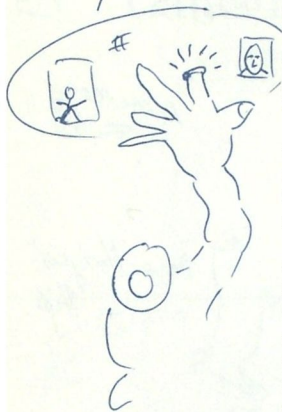
Mrs. Hodges' Hip and The Meteor were totally unaware of each other—they had never even met. The Meteor had been traveling quietly through Outer Space for perhaps 500 years—long before Mrs. Hodges' Hip was in existence. And then it happened! Out of the blue (to coin a phrase) came The Meteor—silent, swift, unheralded. Then the coincidence occurred: Mrs. Hodges' Hip and The Meteor, for one brief moment, met in the same spot in space!

It was rare. The odds are very great against the possibility that Mrs. Hodges' Other Hip will be struck by another meteor.

Still, it could happen . . .



*In Space-Ship
Disaster, Plugging
a Meteor Hole in
a Temporary Way*



Some of the pro worriers say, "You would more likely be killed crossing Michigan Avenue than be struck by a meteor in space."

It is admitted, of course, by the most optimistic of the professional worriers that there are many tiny, sand-like meteors in space, which burn up in the atmosphere of Earth, but which could strike a space-ship traveling through vacuum. Some of these meteors could penetrate the surface of the space-ship and injure an Earthling or permit the air to escape into the vacuum.

A space-liner has a double-hull design and the outer shell takes the blow from such tiny meteors which in this way spend themselves and perhaps never even reach the inner shell.

Cosmic rays are also a good cause for worry. The atmosphere of Earth blocks many of them. Even so, more than a million of these rays and particles penetrate the body of each Earthling every day. But Earthlings couldn't care less about them.

The number of cosmic rays *above* most of the Earth's atmosphere is much greater, however, so a worry can now be properly had. Moreover, in the VanAllen belts, great amounts of cosmic-ray-like radiation abound, and a space traveler would be shot full of holes if he sailed around up there without protection. He should not be out there without protection. He should be in a shielded space-ship, and he shouldn't be out there monkeying around. He should be busy scrambling as fast as possible. Moreover, he could leave Earth through the natural escape hatches—the cone-like, relatively harmless regions over each magnetic pole. So the voyaging Earthman will travel shielded, fast and through a safe-conduct area. One need not seek out space to worry about perishing. Besides crossing Michigan Avenue, one can jump in the lake while weighted down with heavy boots, or eat 15 ears of corn on the cob in a contest with other hogs.

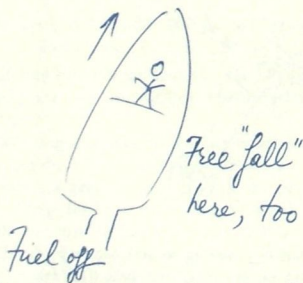
Another legitimate space worry is that about too many g's or too few g's. As every Earthling knows, if an elevator accelerates upward, a person suddenly feels "heavier." If the elevator changes its speed by 32 feet per second, every second, an Earth-person weighs twice as much. The traveler feels "2 g." If the elevator accelerates by *changing* its speed at a clip of 320 feet per second, every second, the traveler would weigh 11 times his normal weight—or 2,200 pounds. Or, "11 g." The traveler would not like the feeling that would accompany this much g'ing. On the other hand, a couple of Earth monkeys were able to take 37 g for a little while.

To allay the fears of Earth-people regarding this, one could say, "It is not necessary to experience a bunch of g's in order to go voyaging through space. The high g's come about only during extreme acceleration. And extreme acceleration is resorted to when Earthlings want to save fuel."

Many Earthlings realize that the time will soon come when the fuel available will be more potent and compact. Then one can lift off the planet with the gentleness of an Earth helicopter, gradually build to a high speed, and then proceed at that constant speed. Earth-people seem to know that even a speed of 500,000 miles per hour relative to Earth will not affect anyone's body in the slightest. It is not the *velocity* that matters, it is the change in velocity, or the *acceleration*. Newer fuels will make awesome accelerations obsolete.

Incidentally, one recalls that this Earth business of 25,000 miles per hour being required to escape from the planet is true only when the rocket is to make a getaway on a one-shot basis. It is not, however, necessary to get away on a one-shot (of fuel) basis. One can go all the way to the Moon at 30 miles per hour. This way, of course, quite a lot more fuel will have to be used up. So what? So Earthlings will use more fuel, from a compact supply and will travel decently.

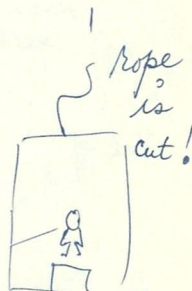
Of course, much worry-time has been spent on the problem of weightlessness—the complete absence of weight. This effect can come about through "free fall."



The scale is dropping at the same acceleration (32 feet per second change in velocity every second) as the Earth-man, so he does not press on the scale at all. He is falling freely; he feels no weight.



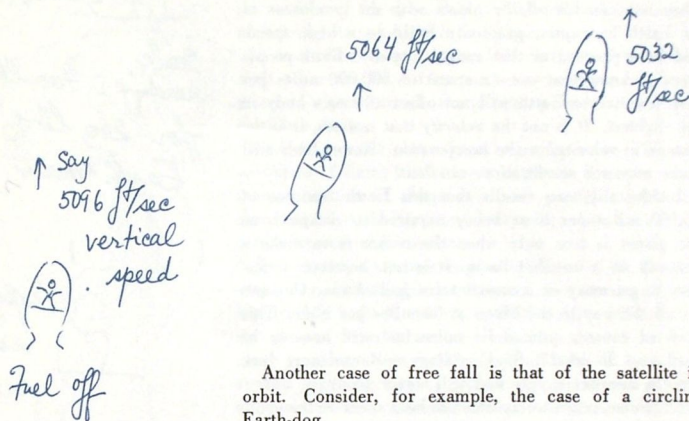
Scale
reading: 400 lbs
for 200 lb
Earth-man



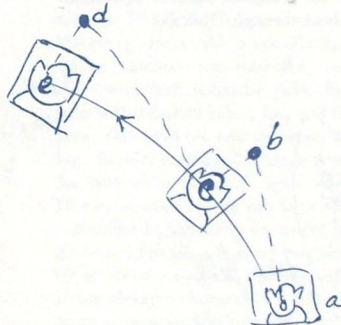
"Look,
Ma,
no
weight!"

Elevator
falling
freely

But a shot into empty space is also a free fall. Even though the vehicle is rising, if the fuel is off, all parts of the space-ship including the traveler, keep up with each other, and the voyager does not exert any pressure on the floor—he is weightless. He is actually *yielding* to the acceleration of Earth, completely, and hence, is falling freely. His vertical velocity is decreasing by 32 feet per second, every second.



Another case of free fall is that of the satellite in orbit. Consider, for example, the case of a circling Earth-dog.



(E)

The Earth-dog is planning to sail out to *b*, but Earth pulls on it, and on the box, and both fall freely to *c*. Since both the box and the dog accelerate equally, the dog does not press against the box, and hence feels no weight.

By now, the dog and box are heading for d , but because of the Earth's pull they really arrive at e , still falling freely, and therefore still feeling no weight. And so it goes, the dog and box falling freely through distances bc , de , etc. That is why an object within an orbiting satellite feels no weight—it is in constant free fall, just like the man who drops when the elevator cable breaks. (The effect of Earth gravity is *not* zero on the surface of the Earth for the case of the falling elevator.) Earth's gravitational effect extends actually to infinity, although it is less the further away an object is from the Earth.

There are two ways for an object to fail to feel weight: One way is to allow the object to have free fall, i.e. let it *yield* to the gravitational pull; the second way is to have some other planet, or a moon, counteract the Earth pull.

The Moon-pull depends on $\frac{M}{B^2}$. The Earth-pull depends on $\frac{81M}{A^2}$. If these are equal (though oppositely directed),

$$\frac{M}{B^2} = \frac{81M}{A^2}$$

By dividing both sides by M , we have

$$\frac{1}{B^2} = \frac{81}{A^2}$$

This gives

$$\frac{A^2}{B^2} = 81 \quad \text{or} \quad \frac{A}{B} = 9.$$

But since $A + B = 240,000$ mi, we get $A = 216,000$ mi and $B = 24,000$ mi.

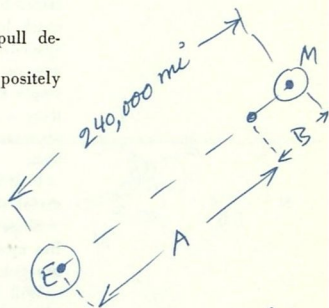
All this reminds us that the Earth itself—and every other planet—is also falling freely in its orbit around the Sun.

But a dog traveling "in the box called Earth" *does* feel a weight due to the fact that Earth has a large mass and, therefore, a gravitational effect of its own. The dog is *not* falling freely with respect to Earth, if it sits on Earth, or runs on Earth. A free fall here would occur only if the Earth's surface parted—as it sometimes does—and the dog could fall. However, the dog is falling freely around the sun, and so is the Earth.

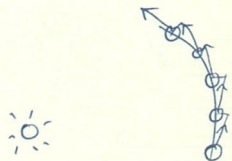
We should inquire whether or not the Earthlings enjoy a free fall or weightless condition.

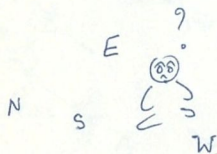
Earth-pull is
balanced
by Moon-pull

object is
9/10 of the
way to the
Moon



Earth is
about 81
times the
mass of
Moon





The answer has already been found: Some Earthlings like it, and some do not. Some can stand it for a long while, others for a short while, and still others become indisposed. Most Earthlings will be able to cope with the weightless condition after some training or with the aid of medication.

But, it is not necessary to travel through space in a weightless condition. If the space-liner, far away from Earth, travels with an acceleration of 32 feet per second, every second, the occupant will feel 1 g, just as he would on the surface of the Earth. It will cost fuel to achieve acceleration. But a change of 5 feet per second in speed would be comforting, and even exhilarating like youthful bouncing on the low-gravity Moon.

Of course, we recall that artificial gravity may be obtained by rotating a segment of the ship, and this requires much less fuel expenditure than accelerating the whole space-liner. Once the rotatable segment begins to spin, it goes on rotating without using fuel, for there is no air in empty space and therefore no frictional air-drag. True, there is some friction at the point of support, and hence occasional fuel bursts are needed to rejuvenate the rotation.

Will Earthlings get lost in space? Is this prospect a major threat to survival?

Some Earthlings may get lost. Others will be found. But most will know what they're doing and where they are going.

Will Earthlings have enough oxygen, and food and water?

If they take enough, they'll have enough.

Earthlings will survive in space. It will be easier than surviving the Black Plague of the Middle Ages or the shenanigans of the early Wild West.

Earthlings will not only survive in space, but they will also enjoy this survival.

For Earthlings are already in space—on a space-ship called Earth. Now, they are merely stepping out from home base, extending their horizon, expanding their imagination, groping for the infinite.

The Race to the Moon

Is the Moon "alive?"

FOR EARTH-PEOPLE, the race is on. Soon, an announcement will come from one region to all others that a space-ship carrying men—residents of the planet Earth—is on its way to the Moon.

Will these men be Americans? Will they be men of the Soviet Union? Does it matter who is first?

Listen—here is A. Dorodnitsin, Member USSR Academy of Sciences:

"The creation of man's first artificial planet demonstrates that Soviet rocket engineering is well on the way to conquering the cosmos . . ."

And here is A. Ilyushin:

"The attainment of success by the rocket (Mecha), whose 3,244-pound last stage is now in orbit around the sun, proves that Soviet science and technology have the necessary prerequisites for the next step ahead . . ."

And Professor V. Dobronravov, Doctor of Science in Physics and Mathematics:

"Manned rocket satellites will be capable of switching from one orbit to another and of linking up with each other. The members of the crew will be able to go out onto the outer surface of the flying machine, in this way making possible the establishment of large, earth-girdling space-stations, of which K. E. Tsiolkovsky himself spoke.

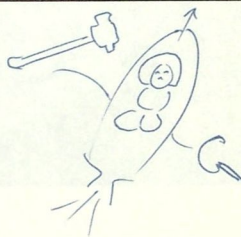




FIG. 6—The Moon, showing the area where Lunik II landed (between the Seas of Tranquility, Serenity and Vapors). The large crater at the bottom of the picture is Tycho.

Some of the routes for a flight to the Moon have already been worked out."

And now listen to Wernher von Braun, the U.S. expert, testifying in January, 1959, before a Senate committee:

"It will take the United States five years to overtake Russia in the intercontinental ballistic missile field even if the U.S. went all-out. Russia's Mehta proves again that the Soviets have more powerful rockets than the U.S., and that the guidance was very accurate."

Is this all true? Americans wonder. Is Russia way ahead in the thrust power of rockets, and is the U.S. destined to be number two, in landing on the Moon? And who is this shaggy Tsiolkovsky whom the Russian space-men seem to revere?

Konstantin Eduardovich Tsiolkovsky was born in 1857 and became a self-educated schoolteacher who eighty years ago started to think seriously and scientifically about MAN INTO SPACE. Not only was he shaggy, but also shy and deaf, yet he set himself the cosmic task of using the laws of gravitation and of planetary motions to bring space down to Earth. The walking creatures of the planet Earth were to soar into the heavens.

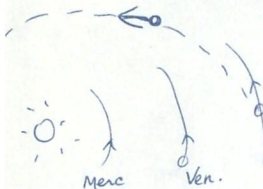
He calculated, wrote articles, and had them published. Tsiolkovsky decided that the rocket was the only possible engine for space, and he obtained mathematically the speed which the exhaust gases must attain to shoot the rocket away from Earth. Tsiolkovsky also concluded that the fuel should be liquid and he wrote this in 1898, when Earth-men had not yet even flown in airplanes. In space, Russia got in on the ground floor.

In the U.S., too, a bold rocket man came upon the scene—another teacher, a professor of physics—but he had one strike against him: He was born a quarter of a century after Tsiolkovsky. Nevertheless, Robert Hutchings Goddard made mighty strides in both theoretical and experimental rocketry. Goddard predicted that a multistage rocket weighing a mere 20,000 pounds could land a small device on the Moon. Not many people listened.

Some important newspapers ridiculed him for believing that a rocket could propel itself through a vacuum. Goddard, shy like Tsiolkovsky, drew within himself, but continued to work. In 1926 at Auburn, Massachusetts, he made his first flight tests with the liquid-fueled rocket.

In 1929, after being badgered and harassed because of the noise of his rockets, Goddard felt compelled to leave Massachusetts and seek sanctuary in the deserts of New Mexico. There, under the blazing sun, in the year 1935,





Bob Goddard's rocket climbed 7,500 feet into the sky. Across the U.S., little groups of men began to gather. They had an out-of-this-world look in their eyes. They talked of a trip to the Moon.

But the Russians already had an edge. The accident of TIME was against the U.S. What can a man do about TIME?

Then, suddenly, came the Sputniks. Russia—184 pounds. Russia—1,110 pounds (with the first live traveler). Russia—2,925 pounds. The U.S.—3 pounds. The U.S.—31 pounds.

The U.S. was pouring on pressure. Could American Earthlings catch up? If only Russia would stand still!

But the Russians refused to stand still. In January 1959 they shot their "Dream" weighing 3,245 pounds (800 pounds payload, 2,445 pounds last stage) away from Earth, past the Moon, and out, out, out—around the Sun. Two months later, the Americans followed with 13½ pounds payload and the burned-out final stage.

Were the Americans catching up? What could they do . . .

Discoverer went up! Thirteen hundred pounds—though not payload.

And the Americans shot an entire Intercontinental Ballistic Missile into orbit. A complete Atlas with its sustainer engine—though minus the two booster engines—went flying 'round the Earth. What did it weigh? Eight thousand and eight hundred pounds! Eighty-five feet long!

The Russians smiled.

"We don't count empty shells," said Dr. Leonid Sedov, Chairman of the Commission on Astronautics of the U.S.S.R. Academy of Sciences. "We congratulate you, but we only count the payload—instruments and passengers. If you want to count the third-stage shell of Sputnik III which went into orbit *besides* the payload of 2,925 pounds . . . How much was your payload? One hundred and thirty-three pounds of instruments? That's all? That's less than the payload of *any* of our three Sputniks. We didn't count the shells of our third stages. Shall we count, for example, the shell of Sputnik III's third stage?"

"It would be embarrassing to us," the U.S. spacemen admitted, "to count that third stage. It must have been about 100 feet long and weighed about 11,000 pounds."

Yet, the Americans were moving along. They were no longer flinging grapefruit into the heavens. The total

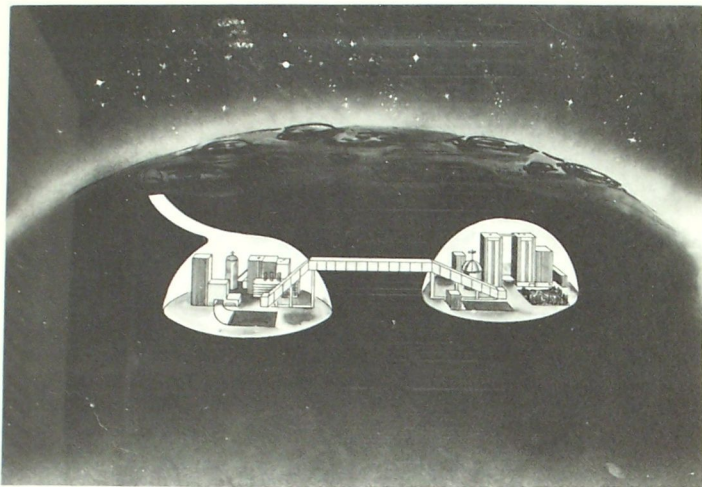


FIG. 7—Underground beachhead on the Moon.

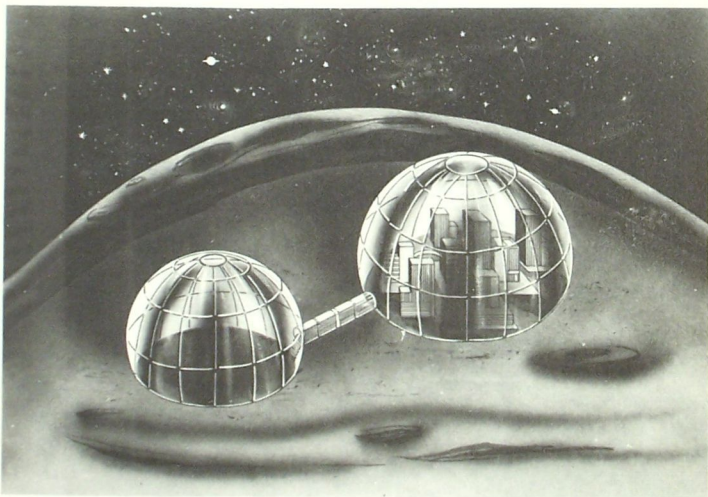


FIG. 8—A Moon-city.

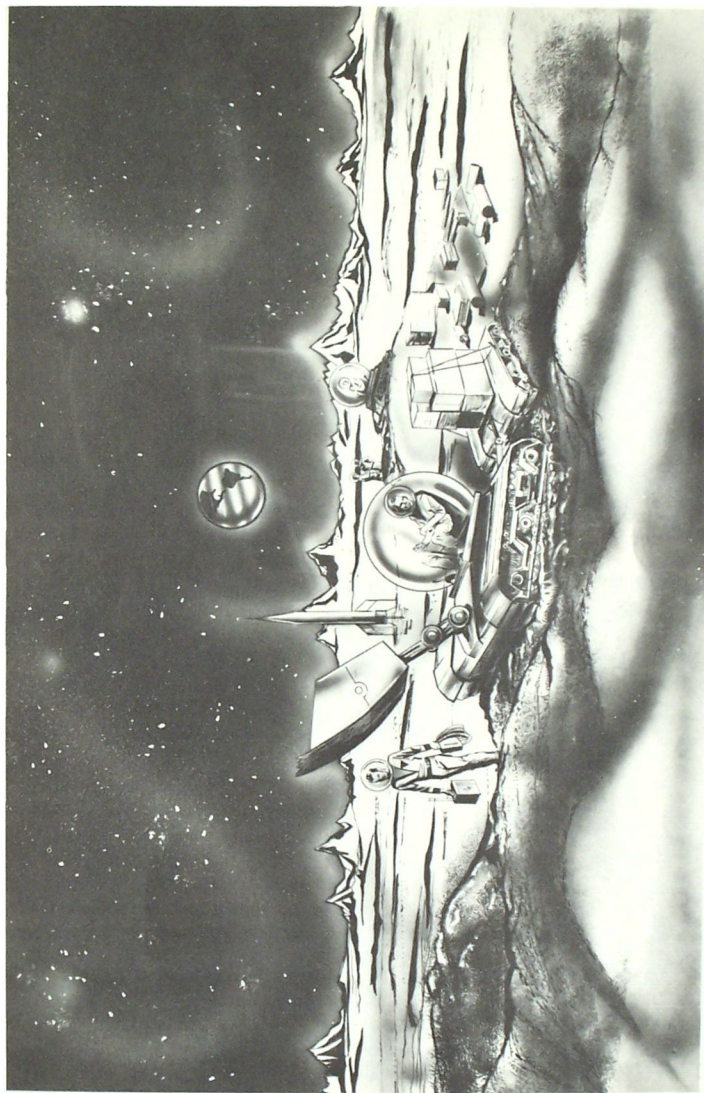


FIG. 9—Building the Moon colony.

thrust of that three-engine Atlas (sustainer plus 2 boosters of the first stage) had been 360,000 pounds. Fueled, on the ground, the Atlas had weighed 244,000 pounds. Was the U.S. entering the Big Time?

The Russians, Americans surmised, probably used a three-stage rocket to launch their "Dream" (Mechta). The total (cluster) first stage thrust may have been 700,000 pounds. "The Russians no doubt have second and third stages more powerful than ours." Yet the gap seemed to be closing.

Professor Oberth—the Tsiolkovsky or Goddard of Germany—recently said: "The Russian space program is probably no more than three or four months ahead of the United States."

But Krafft A. Ehricke, rocket expert for the Convair Division of General Dynamics Corporation, stated in January, 1959, "The present Russian lead is generally estimated to be about eighteen to twenty months . . ."

Meanwhile, 25,000 Americans volunteered to be first man in outer space or to the Moon. Letters have poured into the Pentagon, to the National Academy of Sciences, to the launching sites and to the men running the various U.S. space projects.

"We have stopped counting," says Major William Coleman, information director for the Air Research Development Command at Andrews Air Force Base in Washington.

Many of the men turn out to be married, and have large families. In a number of instances, the wives have volunteered their husbands.

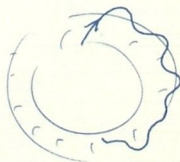
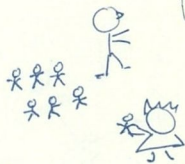
The first seven U.S. Earth-space-men, however, have now already been selected, as everyone knows. And the man-carrying space capsule is now under construction, to take a man into orbit around the Earth.

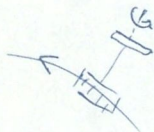
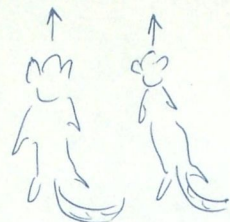
Furthermore, the U.S. is preparing a kind of lob into space—a large airplane releasing a piloted smaller one which zooms 100 miles up, then descends by skimming in and out of the atmosphere. This, and many more probings are considered necessary by the U.S. before the journey to the Moon is undertaken.

Will the Russians make such probings? Or, will they boldly declare, "To the Moon. Now."

They talk about lobbing flights such as the X-15. "Presumably, they too will orbit men—and probably women," say the Americans, "but there is little doubt that they are even now getting ready for the Moon itself."

Space medicine, Earthlings know, is a highly advanced





art in both countries. Not only have the Russians shot Laika around the world in their study of the effects of space on living beings, but on August 27, 1958, they lobbed two other dogs up to a height of 279 miles, the total payload being 3,720 pounds. The dogs and the instruments were recovered successfully.

Many other shots with animals have been made. Americans have sent quantities of mice and monkeys above the atmosphere. Much has been learned about the impact of outer space upon outward-venturing creatures of Planet Earth. The Russians lead. It should not be too surprising to American Earthlings, if they soon hear the announcement by their rivals that the first human passenger has been returned safely from a brief sojourn in space.

Russia also plans to place the whole Planet Earth under view by satellites outfitted with optical and television instruments. Recently, Professor G. V. Petrovich of the U.S.S.R. Academy of Sciences indicated that this project is receiving top priority, the objective being to "guarantee constant observation over the entire surface of the earth and of the air ocean surrounding it." Professor Petrovich said that these "seeing" Sputniks will be launched by the same class of powerful rockets that in January, 1959, sent Mechta soaring out and around the sun.

"These rockets," he added, "are strong enough to put Sputniks into orbit around Earth which weigh many tons . . . The Soviet Union is pushing space research simultaneously in a number of directions: The creation of additional Earth satellites, both manned and unmanned; intensive study of the Moon; and interplanetary flight, including the launching of additional satellites around the sun." Petrovich goes on to disclose that, in addition, "Manned stations in space will be set up tens of thousands of miles away from Earth. These stations will be used as intermediate points on space-ship journeys from the Earth to other planets. This project includes the setting up of space laboratories and observatories . . ."

Russia will also place artificial satellites around the Moon, and will land "softly" upon the Moon heavy containers with scientific instruments and television cameras which will send their observations to Earth.

"Then," says Professor Petrovich, "we will land men on the Moon and will also return them to Earth." The Soviets may send off manned Moon-ships in pairs, so that if one space-ship is damaged on landing, all the Moon explorers may still return using the second space-ship.

"Journeys to and from the Moon may be facilitated by using separate rockets to land containers of fuel on the Moon for the use of men who will land there later and who thus will be assured of fuel for the return journey.

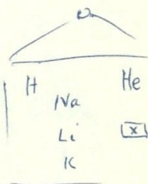
"In interplanetary flight, the Soviet Union already has rockets capable of flights to Mars and Venus, journeys that will take several years each."

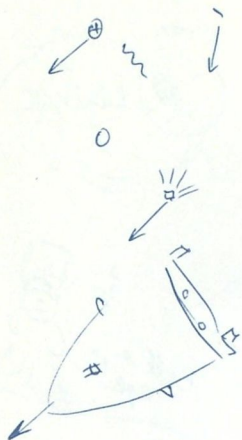
Russian scientists are also planning to send unmanned rockets to more distant planets, to explore the entire solar system with transmitting instruments energized by solar power.

Sometimes one in the United States is tempted to say that perhaps the Russians have greater rocket *power*, but their guidance systems and scientific instruments in general are inferior. In the view of many American experts, this conclusion does not seem to be borne out by the facts. Our Pioneer Four missed the Moon by 35,000 miles, whereas Lunik II (capsule—860 lbs., last-stage container—3,342 lbs.) smacked right into the startled Moon.

Furthermore, Leonid Sedov, Chairman of the Soviet Union's Commission on Astronautics, reported that for the three Sputniks the values of perigee altitude—minimum altitude—were about 140.7 miles, 139.5 miles and 140 miles. This, the U.S. experts agree, indicates that a rather good guidance system was operating.

Accomplishments in space, many Earth-men realize, are closely related to general scientific accomplishments on the ground below. According to one American scientist, "It would be foolish to think that the Russians are bums in electronics, nuclear research, theoretical physics and chemistry, etc., and are good only at popping something into the sky. This does not happen to be so. They have, for one thing, an atom-smashing machine that is the wonder of the West—a device of 10 billion electron-volt power. They have an intense geophysical research program over large polar areas; their chemistry is outstanding, dating from Mendeleyev's work and leading up to Professor Semenov who recently received the Nobel Prize; physics is sparkling, three men recently having received the Nobel Prize for the Cerenkov Effect; their mathematics has always been exceptional—even before the time of Nikolai Lobachessky who laid the foundations of a new geometry which Einstein found indispensable for the Theory of Relativity and the fourth dimension. Russian scientists pour out innumerable papers on pure research of all kinds: The ionosphere, aurorae, atomic





oxygen, cosmic rays, neutrons, micrometeors, archaeology, snow . . .”

Getting back for a moment to rockets and their instruments, here is what we hear from Dr. J. W. Townsend Jr., of the U. S. Naval Research Laboratory in Washington, D.C., after his attendance at the IGY Conference in Moscow, where he saw a spare Sputnik III and its instruments: “This was an impressive sight. From what I saw I came to the conclusion that this satellite was a major scientific accomplishment . . .”

Professor R. E. Marshak, Chairman of the Department of Physics, University of Rochester, had this to say after attending the Moscow Conference on High Energy Particles:

“The U.S.S.R. is sparing no effort to provide the necessary financial support for scientific research. This effort consists of providing both financial and prestige incentives to qualified students in science and engineering, and also of providing funds for a very large technical and educational plant. The stipend of a Soviet graduate student exceeds the salary of an unskilled worker, and the salary of a distinguished scientist in the Soviet Union is as much as 50 times the salary of an unskilled worker. Prestige incentives are equally as great . . . It seems to me that the financial and prestige incentives in this country (U.S.) are not such as to persuade the scientist or engineer to remain in the university where most of the basic research is done and where all the training of new scientists and engineers takes place . . .”

So the Russians are Moon-conscious. Professor Petrovich, in effect, says, “Any day now.”

And what about the Americans? Where exactly is the Moon in their plans? And why should they go there?

They’ll go to the Moon simply because the Age of Space has come to them.

“There is no turning our backs on progress,” some say, “on Science, on the Universe.”

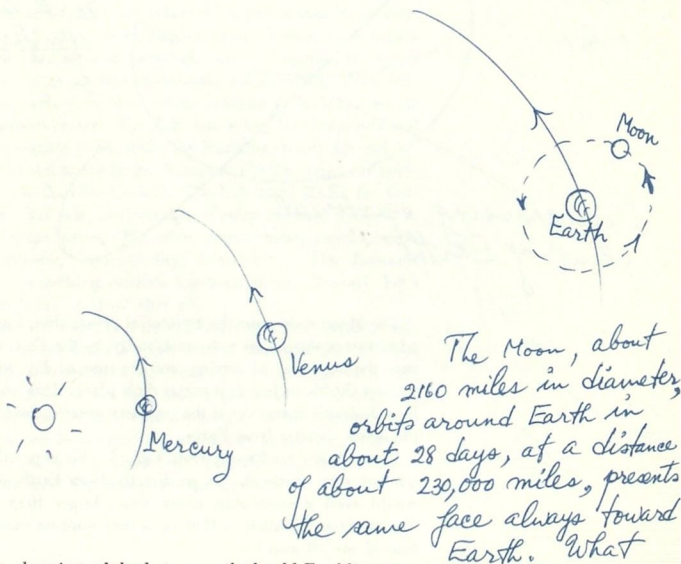
The competition with the Russians, of course, whips them onward. But the Moon itself has little to do with Earthly military needs. “We’re on our way,” say U.S. space-men, “because of questions of prestige, because of the spirit of adventure, because the Moon is ‘there,’ and we can go to it.”

Earthlings—American, Russian and all others—have a rendezvous with the Universe. The time has come—and they are on their way.

Does the Moon have activity within it, as the Russian

astronomer Kozyrev believes? Did he really sight a volcanic burst in the crater Alphonsus? Does the Moon have a magnetic field? Is the Moon made of the same materials as Earth? Was it born from the very Earth itself, whirling out of a certain region which then filled with water and became the Pacific Ocean? Will the study of Moon-dust give clues to the biochemical origin of life? Can the Moon be inhabited by Earthlings? What is the nature of the thin lunar atmosphere? Can Earth people generate a hospitable artificial atmosphere on the Moon to fill the vacuum, and will they erect cities there? Will they use the Moon for a staging area for journeys beyond—far, far beyond?

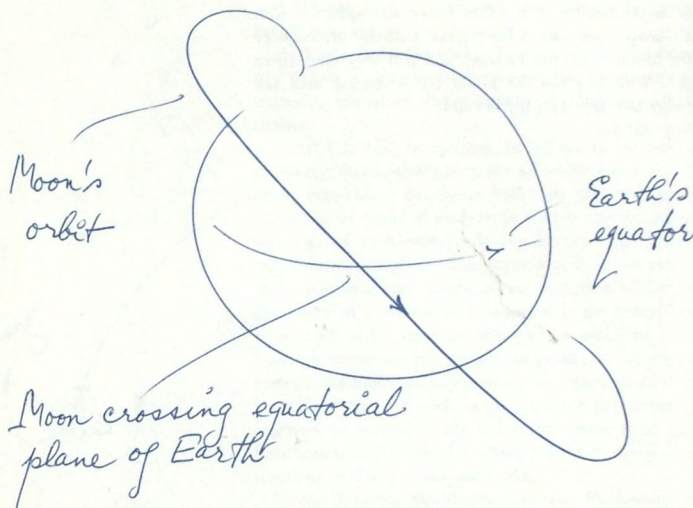
Men will go.



The Moon, about 2160 miles in diameter, orbits around Earth in about 28 days, at a distance of about 230,000 miles, presents the same face always toward Earth. What does the other side look like?

At what time of the lunar month should Earthlings set out? The best time can be deduced from the following facts: If they leave from approximately an equatorial latitude and take off to the East, the rotation of the Earth will be with them and they will have a free gift of about 1,000 miles per hour (eleven-hundred at the equator).

In addition, they will be flinging themselves outward in the equatorial plane. Now the question is, does the Moon cross this equatorial plane? If so, they can have a meeting in space without the need of using more fuel to get themselves "up higher" or "down lower."



The Moon does cross the equatorial plane; thus, Earth-adventurers should set out equatorially, to the East, and time the exact day of leaving, and the time of day, so as to meet the Moon just as it enters their plane. This would be a desirable maneuver if the travelers were to leave for the Moon directly from Earth.

But will they go directly from Earth? This is possible, but not very practical. To go directly from Earth, they would need a space-ship many times larger than the Empire State Building. (That is, if they want an expedition of say 50 men.)

It is also possible to go to the Moon the hard way: A single man, cramped up, with fuel enough to go, land, and fire back off the Moon. But for a moment let us talk about a substantial expedition. In that case, it is more efficient to use a fleet of rockets which go into orbit at possibly 500 miles above the Earth, carrying equipment

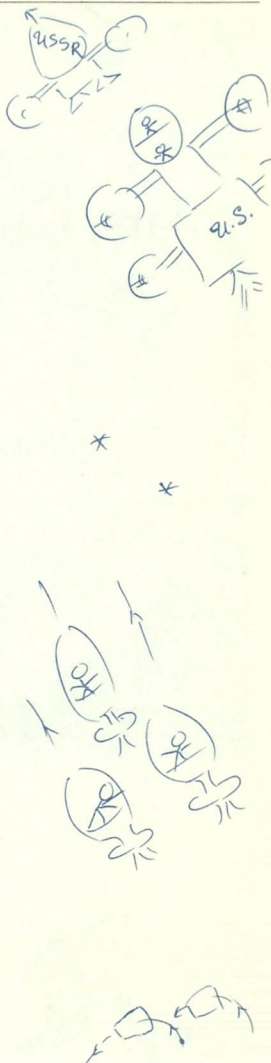
and men to construct a space station. Then, the Moon-ship leaves from the space-station. Of course, the construction fleet of rockets will make many trips between Earth and orbit, lugging equipment.

In the race to the Moon, Americans must answer these questions: "Will we—the U.S.—go directly from Earth?" The answer is "No." The program is set and does not include anything so wild and frantic. The U.S. will build an elegant space-station to accommodate about 50 men, then set out in perhaps two personnel Moon-ships and a cargo ship. Some of the large fuel spheres would be empty shortly after leaving the space station and might be discarded to lighten the load. They could be carried for use as spherical storage huts and even linked into an elegant system of living quarters on the Moon.

The drawing shows the Russians ahead, coasting to an approach—in a basic, relatively unpretentious Moon-ship. The U.S. ship—more elegant, larger, with a much bigger crew (two more ships not shown)—is *lagging*, but firing away in an attempt to overtake the Russians. This, perhaps, is the crux of the whole problem of the U.S. vis-a-vis Russia in space. The U.S. has a big fat, luxurious and comfortable PLAN, while the Russians simply up and go.

The stakes are large. Russia thinks the stakes are nothing less than the Cosmos. The U.S. says, "O.K., the Cosmos. But safe, comfortable, dignity of man, showers in the space liners. Big crew, togetherness, psychological adjustment, compatibility, friendship." The Russians whip something durable together, shout, "Davai! Let's give, lads!" and off they go.

In fact, there is a good chance that the Russians will not wait to build a space station, but will set out from Earth, in a group of small one-man space-ships, each payload about 15 feet long and 6 feet wide! This design is similar to the U.S. capsule design for an orbiting man, but it can be adapted for a two-way Moon trip. It would be tough, a real tough trip. But did someone on Planet Earth say, "The stakes are the Cosmos."



Mars, Canals and Martians

Did the Martians put up their own Moons?



GIOVANI SCHIAPARELLI, an astronomer from Italy, once announced that he saw “canali” on the Planet Mars.

English-speaking peoples immediately began to shout, “Schiaparelli saw canals on Mars.” And “Martians are digging canals!” Then “Oh brother—I knew it! They’re SUPERIOR BEINGS!—They’re out there—man and boy—shovelin’!”

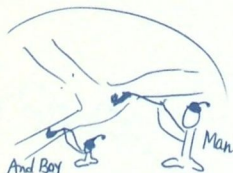
Someone tried to explain that in Italian, “canali” meant, primarily, “channels,” and channels are generally natural clefts, not constructed by anyone. But the Earth-people “dug” canals—even if the Martians didn’t.

Soon, Schiaparelli began to see genuine *canal*-like canals instead of channely ones. And then came Percival Lowell, invincible Earth-spirit: Writer, adventurer, diplomat, romantic who gave his heart to a Japanese lady, and amateur astronomer.

“Mars!” he sang. “Mars—Canals—The Martians. They are there!”

About this time, Schiaparelli’s eyes began to fail him. But Lowell had excellent eyes. In fact his eye-doctor informed him one day after an examination, “Mr. Lowell, your eyes are the best eyes I have ever examined.”

So Percival Lowell made an announcement: “I am taking over Mars from Schiaparelli.”



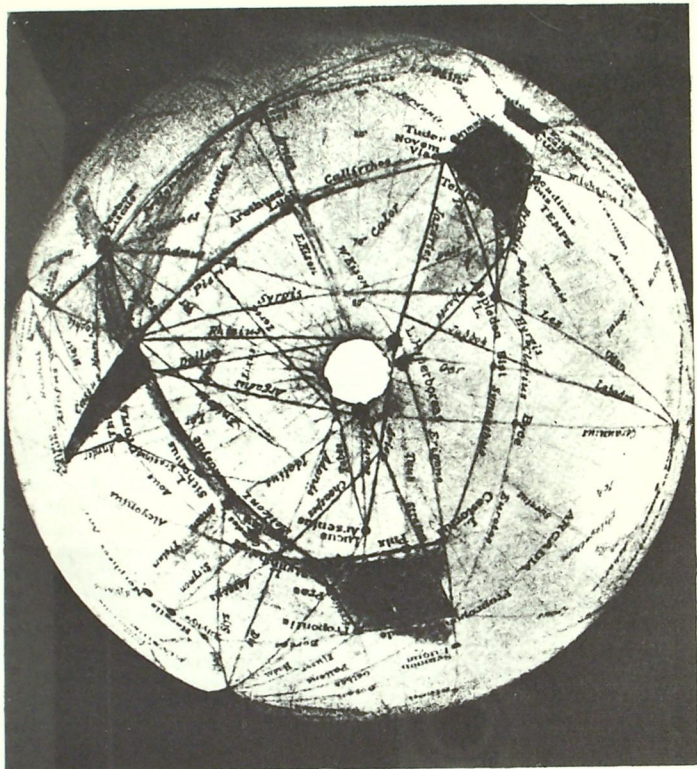


FIG. 10—Mars and its canals (by Percival Lowell, 1905).

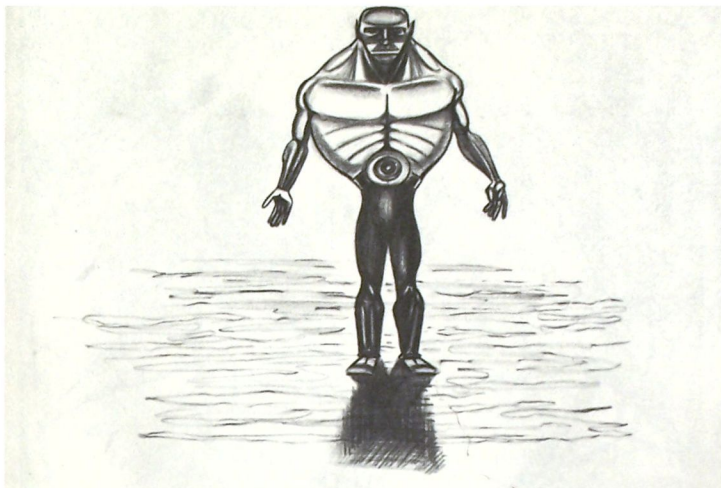


FIG. 11—A Martian . . . maybe.



FIG. 12—Martians (by Swedenborg, a 17th century philosopher).

Lowell took Mars by storm. He was strong, brilliant, gallant, imaginative—and rich. He built an observatory in the Earth-region called Flagstaff, Arizona, and gave, as he said, his strength, his heart, his life and his fortune to the planet Mars.

It was a regular romance between Lowell and Mars. He saw *canals*. He drew them. He saw *vegetation* and he depicted it. He saw *snow* at the polar caps; he divined the presence of *water* and of *atmosphere*.

"Where there is flora," he explained, "there is fauna."

There were beings on Mars—SUPERIOR BEINGS! They were in fact, constructing *canals*, and for a very good reason: Mars is smaller than Earth, with a gravity only 40% that of Earth's. As water evaporates on Mars, it tends to escape completely from the planet because of the weak gravitational hold. Thus, through the long ages, Mars lost most of its water—and most of its atmosphere, too—to the vacuum of outer space. The Martians were forced to conserve their meager water supplies, and to use them efficiently. So, to irrigate the arid lands of the whole planet, the Martians launched a "world-wide" co-operative endeavor of canal construction and water conservation.

The engineering involved in planet-wide construction schemes clearly indicated the superior intellectual qualities of the Martians. But how did they become superior?

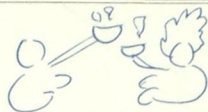
"Mars," explained Percival Lowell, "after its formation, cooled off much faster than the Earth. Because it is smaller. And natural development there was much ahead of that on Earth. The beings have already reached a very, very superior stage of development."

The Martians proved their superiority by being able to cooperate on a planet-wide basis in the canal project to insure their mass survival.

An astronomer from Russia also thinks that Mars has something to do with superior beings. He's not sure there are superior beings there now, but he thinks that at least they were there, once upon a time.

"I say this," he says, "because I believe that the Moons of Mars are artificial."

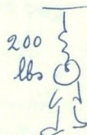
Perhaps millions, or even billions of years ago, Martians began to put up their sputniks. Soon thereafter they put up two large ones—one, about five miles in diameter, the other about ten miles. The Russian thinks that the Moons of Mars are too small to be natural; and they are too near their planet. He believes that in any natural process which produces moons, pieces which find them-



"What chart?"



"Read the
second line
on that
chart."

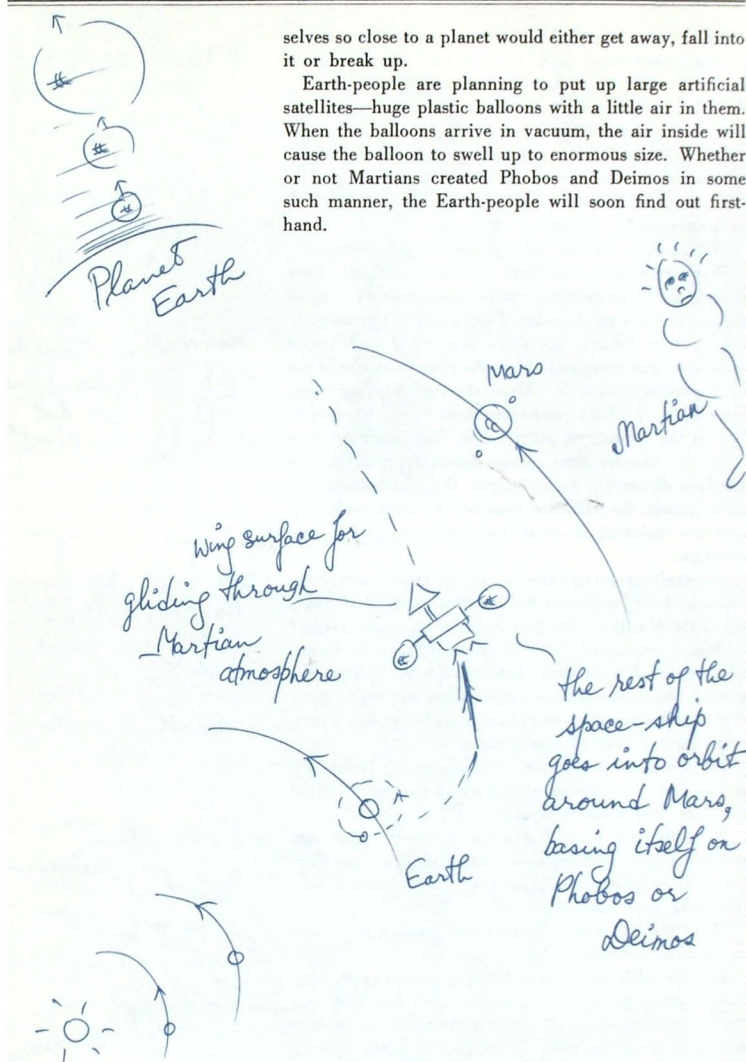


Earth



Mars





selves so close to a planet would either get away, fall into it or break up.

Earth-people are planning to put up large artificial satellites—huge plastic balloons with a little air in them. When the balloons arrive in vacuum, the air inside will cause the balloon to swell up to enormous size. Whether or not Martians created Phobos and Deimos in some such manner, the Earth-people will soon find out first-hand.

Venus

What's under the blanket? Venusians?

THE EARTH IS CLOSER to Venus than to Mars, so adventurers from Earth might go there first (after visiting the Moon, of course).

Venus has been slighted by Earth-people because that planet, unlike the Goddess of Love for whom it is named, is always under cover. The planet has a nearly perpetual cloud cover, and one cannot make out any surface features. Hence, no Earthling can shout, "Canali!" and no Percival can become intrigued by its surface features. Venus, the planet, is modest—completely clad.

Once in a while, the cloud cover parts for a brief moment, and we catch a glimpse of the planet's surface; however, nothing actually is discernible.

Astronomers were once convinced that the cloud cover was sand blowing relentlessly over the surface of the sphere. "Like a Sahara," they said, "but the sand isn't confined to the surface of Venus. It extends out as far as fifty miles, like a thick blanket totally enveloping the planet."

"Then if Venus has a sandy atmosphere," a layman once asked a scientist, "couldn't it have sort of rocky people?"

The scientist shrugged his shoulders. "Perhaps," he conceded. "Maybe a rocky man. And even a rocky



*Venus, the
Goddess — not
heavily clad*



woman. Perhaps they silently stand, giving each other stony glances. And who knows . . . some day, there may be the patter of little pebbles on the kitchen floor."

Opinions now vary. Some astronomers have detected water vapor, and even believe that the entire cloud cover is one of moisture, and not sand.

If Venus does have a great deal of moisture, then an interesting development might be expected: Because of its nearness to the sun, the planet may be a veritable hot-house, the green-house of our solar system.

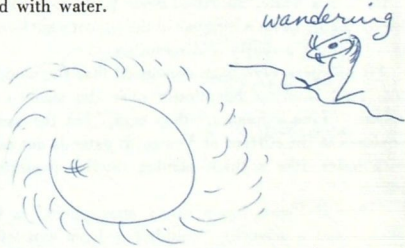
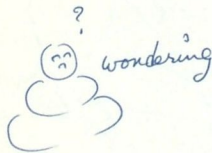
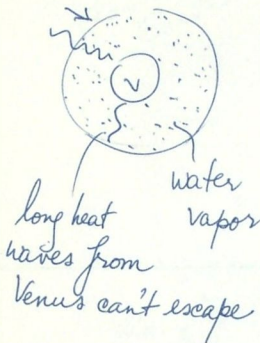
The short waves from the sun are absorbed, causing the planet to become hot and emit "heat waves" which are infra-red or *long waves*. These waves cannot penetrate the cloud cover to escape. Hence, the energy is trapped in the atmosphere; Venus becomes hot and humid; and flora luxuriates. Does fauna follow?

It is conceivable that Venus may be a luxuriant and besogged tropical garden, with richly growing flora and spongy, humid creatures, wallowing about on bat-like wings, wandering through valleys in the night, wondering . . .

An English scientist believes that the white clouds of Venus are a mixture of dust and oil. If so, Venus may be one big fabulous oil field—even more promising than a certain region of Earth (in the United States) which prides itself on its size and on its oil.

Now, why would Venus have more compounds which make up oil—hydrocarbons—than Earth?

Venus is closer to the Sun and at creation time, inasmuch as water evaporates more easily than does oil, more water could have evaporated from Venus, relatively, than from the Earth. Similarly, if the Earth had been created a little further from the Sun, it might now be completely covered with water.



Earthlings are not sure about the period of rotation of Venus, for it is not possible to see a permanent surface marking in order to time its rotation.

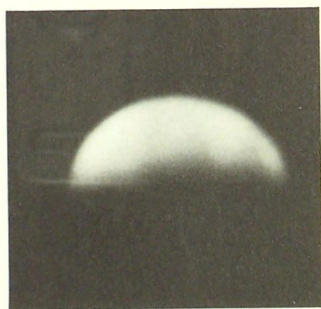
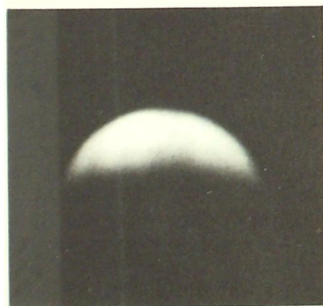
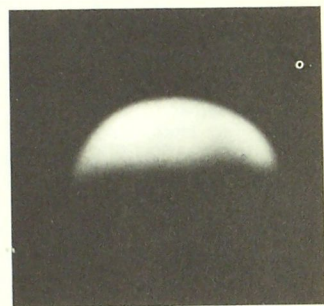
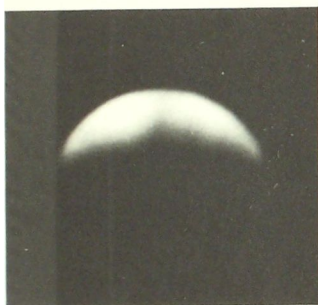
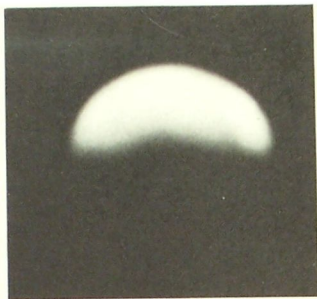
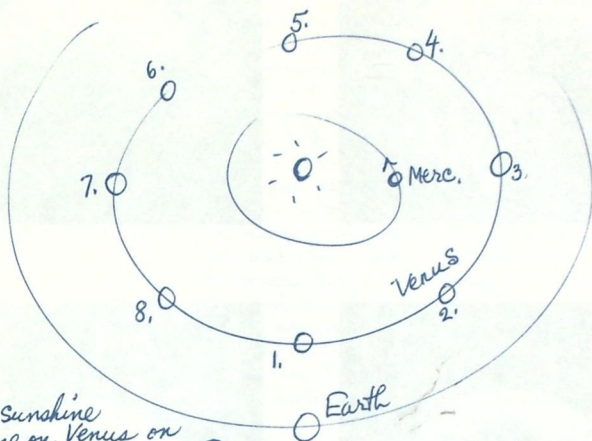


FIG. 13—Venus.

Astronomers are fascinated by the successive appearances of Venus from various positions of Earth.



1. No Sunshine falling on Venus on side facing Earth:  New Venus, Dark

2.  Crescent

3.  half Venus

4.  more Venus

5.  Full Venus

Why is Venus never far away from the Sun, as seen from Earth? Clearly, because it is interior to Earth in its orbit around the Sun. (The same is true, and in a greater degree, for Mercury.) Mars, and other "exterior" planets clearly can be far from the Sun.

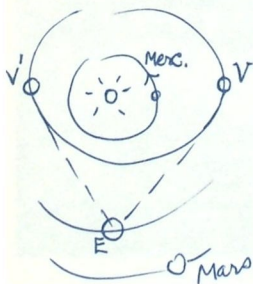
Venus is the brightest of the planets and can be seen even at midday. When it crosses the disk of the Sun, a ring of light is seen around the rim, another indication of the existence of a Venusian atmosphere which may be as much as 50 miles deep.

It is possible, of course, that this ocean of clouds harbors "ocean life"—teeming quantities of many kinds of tiny living beings.

On the side facing the Sun, the surface temperature of Venus (Earthlings surmise) is higher than the boiling temperature of water. (Earthlings, of course, need not land on the hottest side.)

Venus sends a number of different forms of electrical signals out into space, and here is another question waiting for an answer.

Soon Earthlings will know exactly what there is on Venus. They will board a space-liner, and set out for the covered Goddess in the heavens to uncover her secrets.



To Other Planets

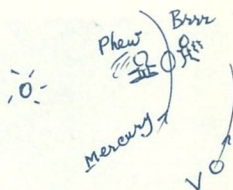
Could Jupiter's moons be inhabited?

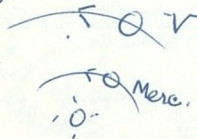
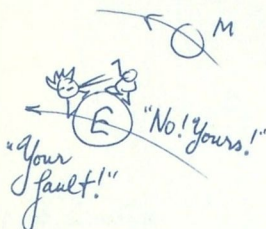
A LANDING ON MERCURY is not likely to be much fun for Earth-people who need air for breathing, and who do not care too much for a temperature of about 770° F. Of course, since Mercury always presents the same face to the sun, an Earthling landing on the opposite side would be cool enough. In fact, he may be too cool. ("Us cats," says Minerva, "don't mind being cool.")

The enterprising Earth-traveler, probably would land where these two zones meet; then periodically turn himself around, as on a spit, so that the cooling parts might warm up and the warming ones could cool off. Actually, such a "twilight zone" on Mercury still doesn't solve the problem of absence of air, so Earth-men will have to lug their own atmosphere, just as in the case of the Moon expedition.

Mercury is dry, cracked, cheerless—but then so is the Moon. To some Earth-people, almost anything can be fascinating. Their reactions may have something to do with their basal metabolism or their basic character.

Jupiter, the forbidding giant, is cloaked in ammonia and marsh gas—methane and hydrogen. Earthlings do not thrive in such environments, and a landing there by an Earth space-ship does not seem a likely prospect in the near future.





Jupiter, however, has 12 moons. A few of these are quite large, and some may even have atmospheres favorable to Earth-people. In that event, an early landing could certainly be expected. At best, it will be cold on the Jovian moons, for they are at very great distances from the sun.

Earth-scientists have recently been receiving radio waves from Jupiter, and some scientists believe that these are due to lightning strokes in the atmosphere of the giant. Actually, as any cultured Earthling knows, the disturbance is caused by Jupiter himself, King of the Olympian Gods, as he hurls shafts of lightning and bolts of thunder whenever he becomes upset by some special misbehavior of Earthlings. This is another reason why Earthlings should think twice before approaching Jupiter, and they might well court his placid moons instead.

It will be relatively easy to land on a moon of Jupiter—and to leave it—because of the small gravitational force. Incidentally, if planets and moons are imagined to be made of the same material—say, “earth,” or “ground”—then it is simple to estimate their gravitational effects relative to those on Earth: The bigger the radius of the planet, the bigger the gravitational force, in the same direct proportion. Thus, since the radius of Earth is 4000 miles, and that of Mars 2000 miles, the gravity on Mars is 50% of the gravity on Earth. Imagine how slight the gravity must be on a moon of Mars—one of them being five miles in diameter, and the other ten.

A man weighing 200 pounds on Earth, would weigh how much on the smaller Martian moon?

$$\frac{2.5}{4000} = \frac{x}{200}$$

or, $x = \frac{1}{8}$ pounds

What a picnic! One could bounce, fly into the heavens, and soar!

Such would be the case also on the moons of Jupiter, particularly on the little ones.

This all comes about from Newton's law of gravitation:

Force of gravity depends on $\frac{M}{R^2}$, where M is the mass of the planet or moon, and R is its radius.

$$F \sim \frac{M}{R^2}$$

The wiggly means “proportional to,” but M is proportional to the cube of the radius; then

$$F \sim \frac{R^3}{R^2}; \text{ or } F \sim R$$

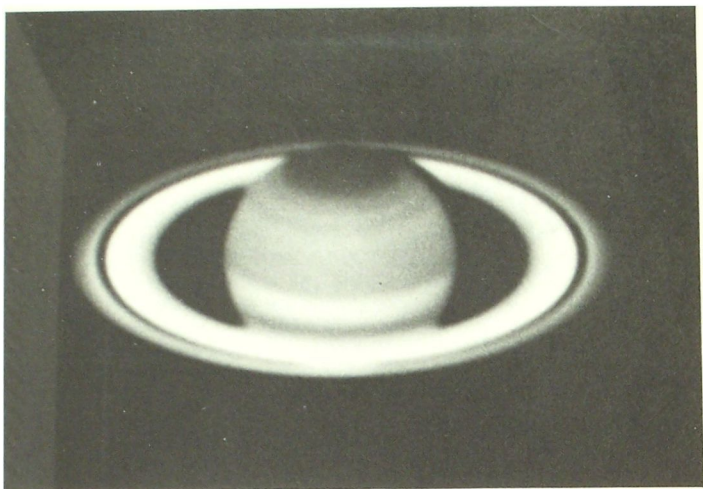


FIG. 14—Saturn.

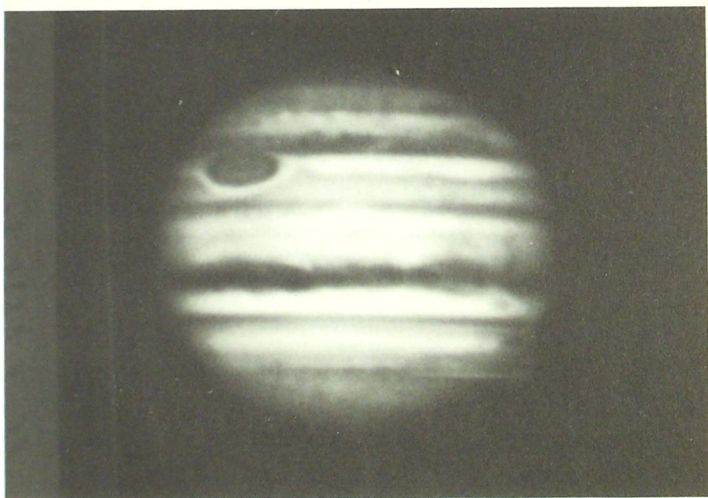
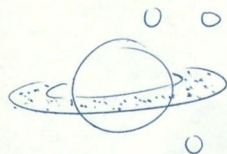


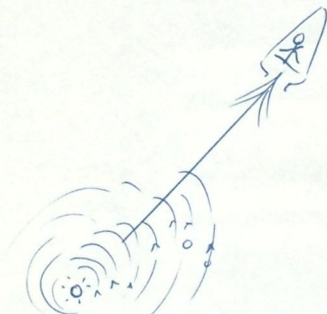
FIG. 15—Jupiter.



An Earth-adventurer should not high-tail it for Saturn, either, for Saturn also has an atmosphere of ammonia and marsh gas. Some of the nine moons of Saturn, however, may have hospitable environments. The rings of Saturn, Earth-astronomers believe, are made of multitudes of fine particles composed of a combination of ice and space dust—"spice," perhaps. One would not *land* on the rings; one could not. One would go right through them.

There is an unearthly cold out there, but Earth-men will arrive, and go on to Uranus and its five moons, Neptune and its two guardians, and to Pluto, presumably circling alone. All of these planets bask in heavenly frigidity, and will give little more than icy stares to the invading warm-blooded space-beings from Earth.

But these beings will reach the outer fringes of their solar system, and will continue further, to other solar systems, other worlds.



Landing on an Asteroid

The pure heavenly curves.

IN THE SPACE between Mars and Jupiter are thousands of little stars called "asteroids." Of course these are not stars at all, but tiny planets, or "planetoids." Some of them are not so tiny, measuring 500 miles across; others are really midgets, as little as one mile across. Many thousands of others are orbiting there, but are so small they cannot be detected by Earth telescopes.

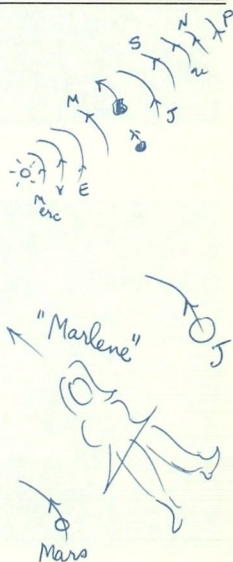
Why are they in the space between Mars and Jupiter?

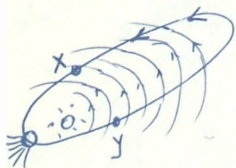
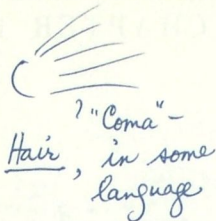
It happens that the space between these two planets is quite wide. "It would seem," Earth-astronomers say, "as though there ought to be another planet there. Perhaps, there once was—and it exploded. Yet, this simple explanation is not adequate. If a planet had exploded there, the pieces would not all be traveling as they are."

An astronomer from Japan has shown that if *five* planets had exploded, the pieces that resulted would be traveling in about the observed manner.

It will be great fun for Earth-travelers, on their way past Mars, to make a landing on an asteroid, especially one with a beautiful name like "Marlene," or "Magnolia," or "Lachrimose," . . .

Some of the asteroids cross over the Martian orbit as they head around the sun, and in such a crossing they may pass rather close to Earth. However, the likelihood





that a wayward asteroid may crash into Earth is small. If such an encounter should occur, many new shapely asteroids would be found orbiting around the sun.

A more spectacular object in the heavens for Earth-people is the comet. Somehow, Earthlings associate comets with omens of impending disaster.

When Catherine the Great was coming to Russia in 1744—she was then only a German Princess named Sophie—she saw the multiple-tailed comet of Cheseaux.

"Oh!" she cried. And her entourage cowered in their sleds under heavy fur.

As it turned out, her life had its crises and excitements and catastrophes. She encouraged a couple of her lovers to strangle her idiot-tsar husband, and then she mounted the throne; also, her official son was fairly repulsive-looking and acted like his father—before he in turn was strangled.

In her old age, Catherine saw another comet.

"Oh!" she repeated. "They have ushered me in, and now they are ushering me out."

After she was ushered out, her ugly son, Paul, became the Tsar, but he was soon strangled by a couple of other plotters. Paul, however, had not seen any comets.

So, it is possible to have hard luck without glimpsing a comet (or a black cat). No doubt, it is also possible to live to a considerable age after staring at a comet for days on end.

All Earthlings know about Halley's comet. Some of them saw it in 1910 (for about one month); others expect to see it in 1986. Halley's comet travels in a long elliptical orbit; Earth-people begin to see it as it approaches, keep on seeing it until it gets too close to the sun (at x) and see it again for some time after it passes y and heads out again into distant space.

Many Earth-people do not know that there are more than 100,000 comets in their solar system. But most of them are very dim and can be detected only by telescopes. So, the sun controls only nine planets, but it controls 100,000 comets.

Some of the comets that travel around the sun come from outside the sun's domain—from empty space and from regions of other solar systems.

If a comet comes from outside the solar system and barely gets away, ending up with zero velocity relative to the sun, it traces a parabolic path; if it gets away and is still going strong "at infinity," it traces a hyperbolic path.

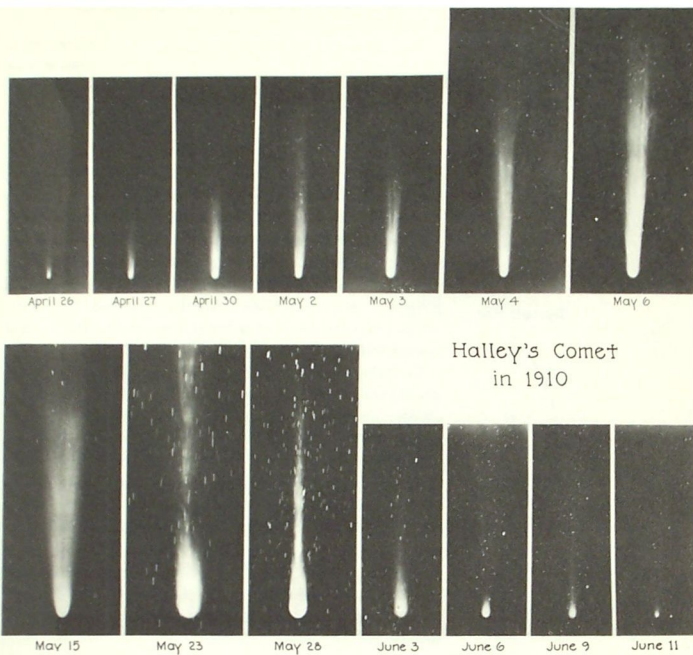


FIG. 16—Halley's Comet.

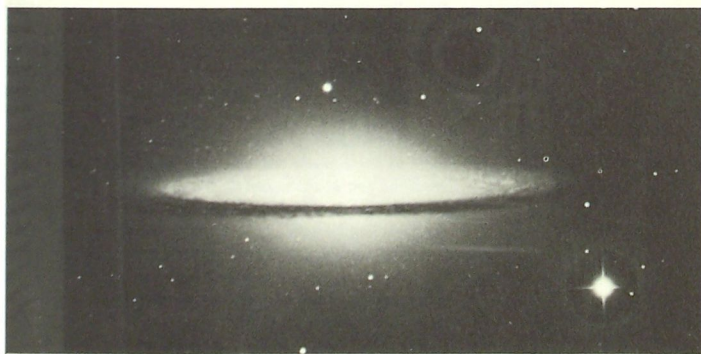
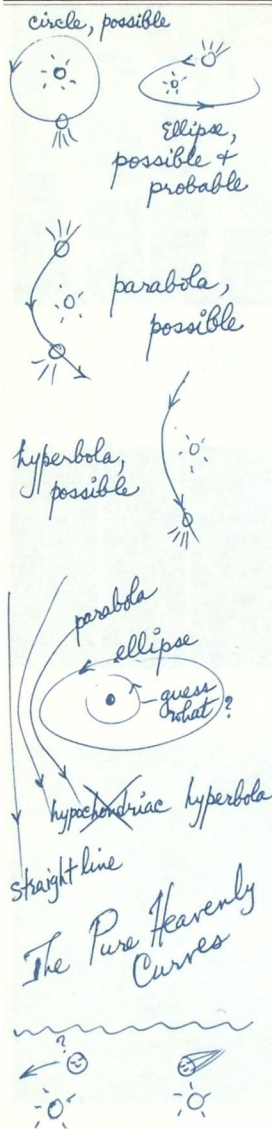


FIG. 17—Spiral nebula in *Virgo*.



If a comet comes past the sun at a great distance with a tremendous speed, it will continue traveling essentially in a straight line. These, then, are the pure heavenly curves which *one* single body, like the sun, can make another body, like a comet, follow in space.

One can think of the reverse situation: An object at a great distance, moving with some speed and traveling in the general direction of the sun, will make a hyperbola around it (unless it heads exactly for the sun and crashes). An object at a great distance, falling freely—with no initial rush of speed—will make a parabola around the sun. The slightest decrease in speed of a parabolic comet will make it an elliptical one; the slightest increase in speed of a parabolic comet will make it a hyperbolic one.

Earthlings have investigated about 1000 comet orbits; about three-fourths of these are parabolic and about one-quarter are elliptic, with a few orbits being hyperbolic—perhaps.

One Earth-astronomer has found that although twenty comets had orbits which were hyperbolic when near the sun, none of the comets when far from the sun had enough velocity to escape the solar system. Somehow, the comets lost some of their speed, which on pure theory they should have had. They seemed to have suffered some sort of drag in rushing through "free" space. On the other hand, some comets, through a proper approach to the planet Jupiter, might be given an extra yank which tosses them out of the solar system. Comets, by the way, do not have tails when they are far from the sun. But as they approach the sun, a tail "boils" into existence.

Comets, as Earthlings guess, have little mass. This can be determined from the fact that they hardly perturb other heavenly bodies near which they pass. Also, one can see their light-hearted nature from the fact that as a comet gets close to the sun, the sun's rays press away most of the comet's tail and even separate it completely from the rest of the comet.

Some Earth-astronomers believe that the tail of a comet is not pressed away by the pressure of the sun's light, but rather by particles shot out by the sun from its storm areas, the sunspots. These particles hurled into space are electrons and protons, and in a mighty onrush they sweep away the flimsy comet tail.

A comet, or at least the tail, is light puffy stuff, Earthlings surmise. And a comet's tail occasionally brushes

over Earth! And in fact, Earth passed through a comet's tail in June 1861 and again through part of the tail of Halley's comet in May 1910; most Earthlings were not even aware of it. It must be admitted that a head-on encounter would have other consequences, for the *head* of a comet, or *nucleus*, is believed to consist of solid substance, much of it meteorlike.

Some comets in their elliptical orbit may take thousands of years to return; others come back fairly soon. Encke's comet, for example, returns every 3.3 years. Its period, incidentally, is growing shorter by 2.5 days every 100 years, and Earth-astronomers do not know the cause of this decrease, even after making allowance for all known perturbations.

Occasionally, a comet may break up and continue as a double, or even as six separate comets.

Sometimes the same comet is rediscovered, and renamed. Thus, a fair-sized diplomatic ruffling of feathers occurred on the planet Earth when the "Comet Jurlof-Achmarof-Hassel" was named "Comet du Toit-Newjmin—delporte."

One can guess what must have happened at the meeting of the International Astronomical Union in 1948 when a resolution was passed, "That the periodic Comet Pons-Coggia-Winnecke-Forbes should in future be called Comet Crommelin." It is a fair guess that Pons, Coggia, Winnecke and Forbes weren't present at the meeting.

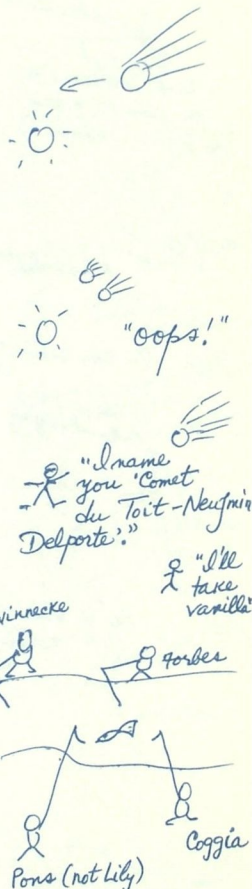
The tails of comets remain intriguing for Earthlings. Some of them are millions of miles in length. Cheseaux's comet (Catherine's omen) had six tails. Borelly's, of 1903, had nine tails.

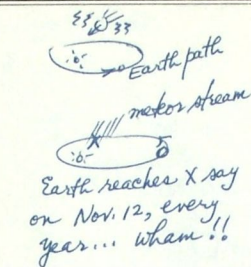
Comets are often like lizards. As they pass the sun they discard their tails, and begin to grow new ones.

The nucleus of a comet is relatively small, even as little as two miles across. Materials making up the nucleus—some hard, some vaporous—may consist of iron, magnesium, carbon, hydrogen, nitrogen, oxygen, sodium and other elements.

Some comets have a definite connection with meteor streams in space. Thus, a comet may experience the "shakes" and leave a swarm of hard chunks sailing through space. Then, as the Earth crosses their pathway, a meteor "shower" is observed by Earth-people. The following year, on the same date, the Earth again passes through the meteor stream.

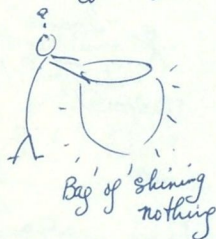
As an example of the connection between a comet and a meteor stream, one might cite Encke's Comet and





Then, (no star subsiding)

(no stardust, cometizing)



the Autumn Taurids. (The meteor showers are often named for the constellations with which they seem to be in line.)

One of the biggest meteor showers ever recorded by Earth-observers was that of the Leonid shower of November 12, 1833, when meteors, or "shooting stars," were seen to swarm through the heavens at the rate of about 200,000 per hour. Space-ships in those regions of the sky might have had some close calls.

Among the theories of comet formation that Earth-astronomers have evolved, one could mention these: Supernovas—fast-exploding stars—fling stardust into space, which gathers into a kind of celestial snowball or powder-puff; a second theory supposes that a comet is formed when the sun, in passing through the thin space-dust, gathers much of this space-dust and whirls it into a puffy formation.

By the way, a comet does not shine by its own light. The comet is not an active organization; it is just a flimsy collection of dead stardust, as near to being a luminous bag of nothing as one can get. And the comet shines because its puffy dust reflects the light of the sun.

The question of tail formation in a comet has attracted the attention of several Earth-astronomers. One theory in vogue is this: When the comet is rounding the sun at perihelion—the point of closest approach—the increased speeds that occur there produce violent internal collisions among the swarms of inner pieces and among the dust-swarms, too. All this produces an agitated warming; gas "boils," evaporates, becomes a tail.

"Comets," says one Earth-scientist, "are just dirty ice. And at perihelion when boiling occurs, some of the dirty ice melts, evaporates and produces a tail."

"No," says another scientist. "A comet is a big fat bag of wind—but silent and shiny."

Many meteors survive the friction-burning in Earth's atmosphere and make a frantic landing as "meteorites." Some of these meteorites might be called "large":

(a) A meteorite that fell in South Africa, and is still where it fell, is the largest known, being 60 tons. "Hoba West" is the name of this heaven-sent chunk.

(b) The meteorite brought from Greenland by Admiral Perry in 1897 is 33 tons in weight. It is the largest one in captivity—the largest one stuffed into a museum.

(c) An enormous amount of devastation was caused by the one which landed in a Siberian forest area in 1908 when herds of animals were killed.



(d) The meteorite which millions of years ago ploughed into Arizona leaving a great crater may have been a 50,000-ton job.

In the Earth-region called "Canada," scientists have found startling evidence for a new perspective on meteorites. After making observations from airplanes, scientists have concluded that many of the enormous depressions—one 400 miles in diameter—were caused by a gigantic rain of meteors that occurred about 300,000,000 years ago.

At that time, the Canadian scientists believe, three planets about as large as the Moon collided with a heavenly shudder, sundering themselves into fragments. Remnants of this ferocious collision—smaller meteors—are still pelting the Earth's atmosphere, and Earth itself.

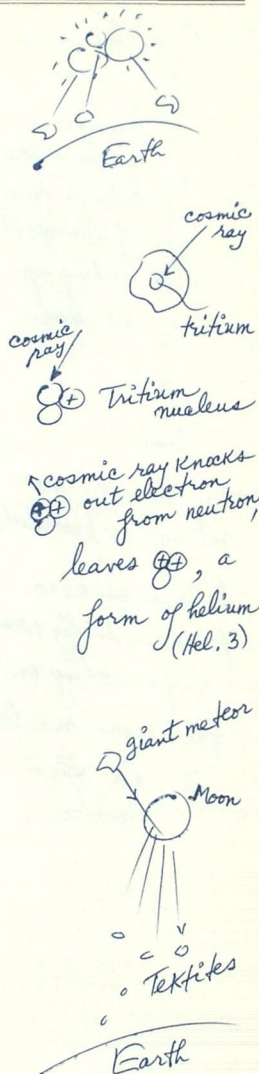
The time of the catastrophic event, 300,000,000 years in the past, can be determined this way: The meteorite has some helium gas in it produced *during the flight* of the chunk through space. How was it produced? By cosmic rays acting on the heavy hydrogen—tritium—of the meteor. From the amount of helium produced by the cosmic rays, it is possible to calculate *how long the meteor has been in flight*, hence, the date of the collision-explosion.

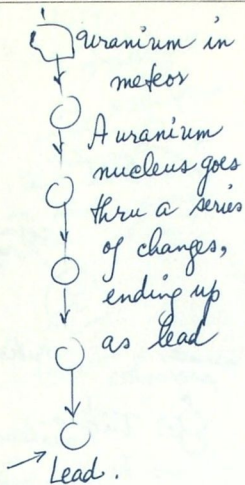
The composition of meteorites depends on the meteor type. Some are "Iron" meteorites—90% metallic iron, 8% nickel, 2% minor constituents. Some are "Stony," mostly magnesium and iron silicates. Most of the stony meteorites contain a rather finely divided metallic distribution, amounting on the average to about 10% of the weight, though in individual cases 50% is possible.

The percentage of each element in meteorites in general can be indicated about like this: iron 46, silicon 12, magnesium 10, nickel 4, sulphur 1, aluminum 1, uranium .0003. Most meteorites also contain at least traces of every element known on Earth except neon, argon, krypton, technetium, xenon and element number 61, Cp. (What is it?) The helium, one should say, is present only because the uranium and the cosmic rays generate it.

Most of these absent elements are the volatile kinds, and are inert—not reacting with other elements. How would this account for their absence? Or does it? Of course, the man-made elements are missing also, elements such as plutonium, americium, curium, neptunium.

A mysterious, glassy, silicon-type of meteorite—generally in the form of smooth black ovals or disks—is found in the Earth-regions of Czechoslovakia, Australia,





On the way, some helium is produced.

Helium is also produced by cosmic rays acting on the tritium nuclei $\oplus$ in the meteor...

and Indo-China in large numbers. Some scientists believe that these "tektites" are teardrop-like splashes from the Moon, originating ages ago when the Moon was solidifying and chanced to be smacked by giant meteors.

The age of the meteorite material—not, how long it has been in flight—can be determined this way: The uranium in a meteor goes through a series of nuclear changes, winding up as lead. The rate of conversion for uranium to lead is known from experiments on Earth. Therefore, from the amount of lead already produced and the amount of uranium not yet converted, one can calculate the actual age of the meteor. Of course, one must not forget that during the process of changing to lead, uranium also creates helium. So, one must be careful to subtract this uranium-produced helium from the total helium found in the meteorite, in order to obtain the amount of helium produced by cosmic rays (from which the time of flight is to be calculated).

The proportion of lead in the meteorite samples gives the time of formation of the chunk or planetoid as about 4.5 billion years. Creation, then, or the Universe, is at least 4.5 billion years old.



Other Worlds

Flying saucers from out of this world?

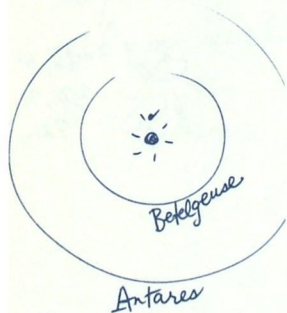
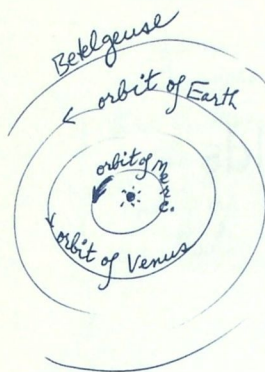
AS EARTH-PEOPLE look up into the sky on a clear night they see a great many stars. Most Earth-people would say they see "millions of stars." Actually they see only about three thousand stars with the unaided eye. True, binoculars or opera glasses will bring thousands of other stars into view, and with the aid of telescopes of higher and higher powers, literally millions and millions of stars actually do become visible to inhabitants of Earth.

The Milky Way is a vast region containing billions of stars. And each one of these stars is like the star which Earthlings call "our Sun!" To put it conversely, the sun is nothing more than an average star. Since the sun has a planet inhabited by advanced beings capable of building flying machines, other suns, or stars, could also have planets with beings capable of building flying machines.

Earth-men often examine this question of other suns—that is, the stars—and their possible planets. The sun does not look like the stars, it is true, but that is only because *Earth* is closer to this particular star called the sun. Anyone can easily visualize what the appearance of another star would be from a planet which is associated with that star. From that planet, the other sun would look about as "our sun" does to residents of Earth.

Now, to return to the size and condition of "our sun."





The sun is a flaming body busy with the production of energy by nuclear atomic processes, giving out warmth to the planets around it, though not very much to the distant Uranus, Neptune, and Pluto. The size of the sun may be indicated in terms of its diameter which is about 866,000 miles.

So here we have a luminous energetic body, spherical, and not quite one million miles in diameter. Is this very large? Is this very impressive? Obviously these words "large" and "impressive" are relative terms. To Earthlings the sun seems large and its heat-producing ability seems impressive. But let's compare "our sun" to the other suns for a moment. The fact of the matter is this: There are a great many stars which are much smaller than the sun and there are a great many stars which are larger than "our sun" and there are a great many stars which are about the same size as the sun.

For example, the star—or sun—called Betelgeuse (the arm-pit star in the constellation of Orion) is much larger than our sun. In fact, Betelgeuse has a diameter of about 250 million miles. Our sun could be placed within the disk of Betelgeuse and would be like a grain of sand lying on a silver dollar, for it would take about three hundred of "our suns" to fit in a line across the diameter of Betelgeuse. If our sun is placed at the center of Betelgeuse, the planet Mercury would be revolving around the sun and still be within the disk of Betelgeuse. Furthermore, the planet Venus would be revolving around Sun and it, too, throughout its orbital revolution would lie completely within the disk of Betelgeuse. Earth in its "great" yearly travel around Sun would still have its orbit lying entirely within the disk of this massive star, inasmuch as Earth moves on a circle 93 million miles in radius and here we have the disk of Betelgeuse with a radius of 125 million miles.

Betelgeuse, however, is not the largest of all the stars that are known. Far from it. One might mention, for example, Antares which is in the constellation of Scorpius. Antares is about four hundred million miles in diameter. Therefore, Betelgeuse itself could be dropped into Antares with plenty of space left.

Now as to *volume*, or space occupied by Antares: Since Antares is about 400 times as wide as the sun, the space Antares occupies is $400 \times 400 \times 400$, or 64,000,000 times as great as that occupied by Sun. Thus, 64,000,000 suns could be dropped into Antares.

And there are, of course, many stars larger than Antares. At the other extreme, a midget star was discovered

recently whose diameter is only 2,500 miles. Compared to this midget star, Sun is a giant, whereas compared to Antares, Sun is a midget. This is why we have referred to Sun as about an average star.

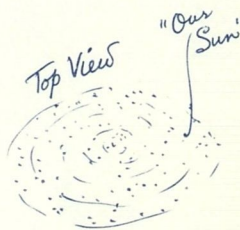
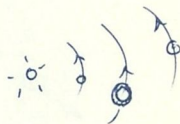
We are now ready to discuss the possibility of the existence of other solar systems, or families of planets, surrounding some of the other suns. One should not make dogmatic statements with regard to the existence of solar systems for other suns, but from the laws of probability or pure chance it is clear that if an average star, such as Sun, can have a family of planets, other suns, whether "average" or not, could conceivably have families of their own. No doubt in certain cases all of the planets of a sun would be much too close and therefore too hot to make existence of life possible; and in many cases the planets would be too far from their sun and therefore far too cold to make existence of life possible. In some cases though the planets may be just right in position, there yet may be an absence of atmosphere—especially if the planet is so small that the gravitational hold on its atmosphere would be weak.

"But no doubt," reason these Earth theorists, "in many cases the planets would be at just the right distance and have atmosphere, water, and vegetation, just as is the case on the planet Earth circling around its own star, Sun."

There is a way, in fact, of making an approximation as to the number of possible "Good Earths" which could exist surrounding the stars all about us. By "Good Earths," of course, Earth-scientists mean planets having air, water and vegetation suitable for supporting life as we know it. Before making the estimate they return to the question: How many stars are there? Or, how many suns are there in the heavens?

"Counting the stars of the Milky Way and all the other stars which are in a kind of group together, one can say today that we belong to a congregation of stars numbering about two hundred billion." That is to say, Sun (and, of course, his family of planets) is a member of a large collection of stars grouped together in a great family of stars which Earthlings now call "Our Galaxy," or just "Galaxy."

To an outside observer, Galaxy would look like a flat pillbox of stars. Some Earth astronomers have described it as a circular watch-case of stars. In any event, the stars are clustered together in a roughly circular form with an approximate diameter of 100,000 light-years; that is, the distance which light would travel in 100,000 years, at





the rate of 186,000 miles per second. (One light year is about six trillion miles.)

The thickness of this cluster, Galaxy, is about 20,000 light-years. That is why Earth people describe it as a pillbox (a cylinder of greater diameter than depth).

Now where is Sun in this collection of stars? Sun is located about $\frac{2}{3}$ of the way out from the center towards the edge. So it turns out that Sun is about 20,000 light-years from the circumference of the pillbox.

In any case, the point of interest here is that Sun is not at the center of the Galaxy, nor is Sun an unusual star in size or in any other way. Earthlings see once again that Sun is just an average star and is located in just an average spot within Galaxy.

Considerations of this type lead Earth-men again to remark that other stars or suns have as much chance of having families of planets of their own as has Earth's particular sun. Now they are ready to make an estimate regarding the number of stars (and we have seen there are about two hundred billion of them) which have Good Earths of their own.

Those Earths which are either too hot, too cold, or lacking in other properties necessary for the maintenance of life are, of course, omitted from this estimate. In this spirit, several Earth astronomers have estimated that in Galaxy there are about one hundred thousand Good Earths with living beings on them, "some as advanced as we are, some far less advanced than we are, some more advanced than we are."

Insofar as expectations of flying saucers from outer space are concerned, it is from some of these Good Earths which surround other suns that visitors might come to our planet. Earthlings seem not to expect visitors from the members of their own Solar family, such as Venus and Mars, but they could expect visitors from another star's family, from one of the Good Earths among the one hundred thousand estimated.

The question now arises among Earth people, why haven't some of these visitors already arrived on Earth? The answer, in part, may well be the distance from another solar system to ours. In fact, the nearest star to us which might have a Good Earth around it is Alpha Centauri which is about 24 trillion miles away.

Astronomers would say that it is about four light-years away—that is, that light would take four years to reach us from Alpha Centauri (light from our sun reaches Earth in about eight minutes).



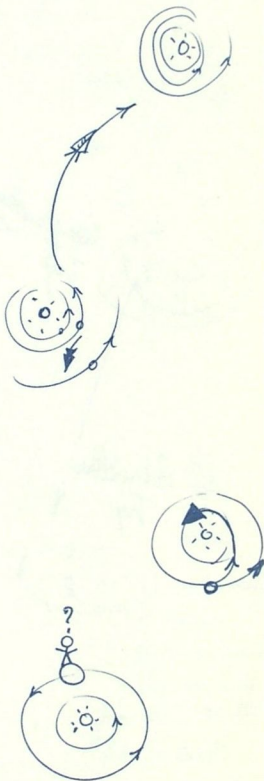
Earth astronomers reason, "The nearest possible Good Earth outside of our solar system lies at a distance of about 24 trillion miles and a space trip from such a Good Earth to our Earth in a flying saucer or a space ship would take, at the very least, 75 years." When one considers the fact that any visitor from another Good Earth would have to reserve 75 years more for his return journey, we can see that there may not be a great many enthusiasts when it comes to leaving on such a trip. How much fun would there be in setting out and traveling through space and space and space for approximately 150 years even though admittedly there might be some excitement in landing on another Good Earth?

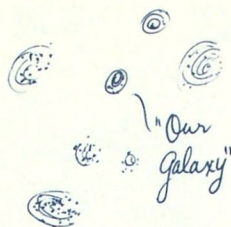
It is clear, then, that Earth has not been the goal of vast armies of space travelers. Furthermore, what if the nearest star, Alpha Centauri, does not have a Good Earth? Then perhaps one might receive visitors from another nearby star, say at a distance of 54 trillion miles or nine light-years. A round-trip journey from a Good Earth to this star then would take over 300 years. And what if even this star did not have a single Good Earth? Then one might hope to expect visitors from a Good Earth of the next nearest star. After all, our estimate has been that there are about one hundred thousand Good Earths belonging to about two hundred billion stars. This is a ratio of one in two million and so perhaps there is no Good Earth among the planets surrounding even the sixth, the seventh, the eighth, or the ninth nearest sun. Accordingly, one sees that the nearest Good Earth might be one which revolves around the thousandth star away from us, or the ten thousandth, and in such an event, a round-trip journey might well take many thousands of years.

So, do Earth-people expect visitors from space?

"It might well be," they say, "and in fact it is very likely, that space ships or flying saucers do travel from planet to planet and even from one solar system to another, but it is quite clear that our particular solar system is not near another one where there is an advanced Good Earth."

And now Earth-people consider another intriguing question: "Are there any more stars in space than those which are contained in Our Galaxy of two hundred billion stars?" The reply, of course, is that there are a great many other galaxies in space visible through our telescopes. In fact, thousands of galaxies such as ours have been photographed already. And it is estimated that the great Palomar tele-





scope is within reach of one trillion galaxies (1,000,000,000,000). So we see that the space which we know at the present time contains multitudinous congregations of stars separated from each other by vast distances, each galaxy containing about one or two hundred billion stars and in each galaxy about one hundred thousand Good Earths, many of which doubtless have space ships or flying saucers flitting from planet to planet.

Earthlings like to give their friends some idea of the distances between galaxies.

For example, they say, "The nearest galaxy to Our Galaxy is about 16 hundred thousand light-years away. That is about $6,000,000,000,000 \times 1,600,000$ or 9,600,000,000,000,000 miles."

To summarize the question of flying saucer trips or space ship trips as many Earthlings see it:

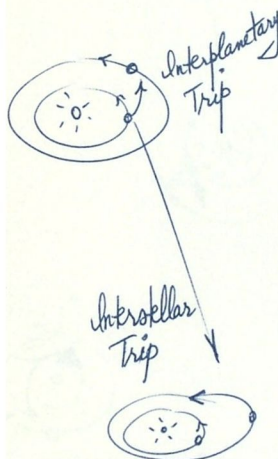
1.) They do not expect any visitors from other planets of their own solar system, that is, from Mercury, Venus, Mars, etc. These would be called "interplanetary trips."

2.) Such visiting no doubt does exist, they believe, among the planets of other solar systems where there is more than one Good Earth and sufficiently advanced civilization—at least slightly more advanced than Earth's.

3.) The Earth-people might some day get a visit from a traveler of a Good Earth belonging to another solar system, though this would have to have been a "highly adventurous" expedition for the visitors. Such a journey would be called "interstellar," meaning, of course, from one star to another star. More precisely, it would be the trip from a Good Earth of one star to a Good Earth of another star.

4.) Finally, Earthlings conclude, one might conceive of a galactic trip, and that would be, of course, a visit from a Good Earth in one galaxy to a Good Earth in another galaxy. They hasten to remark, however, that an inter-galactic trip in actuality seems like an impossibility at least insofar as a trip by living beings as Earthlings know them is concerned. Also a fantastic amount of energetic fuel would be required to escape from one galaxy to another, overcoming the pull of gravity. There is the question of the length of time the trip would take. Obviously, since the nearest galaxy is 16 hundred thousand light-years away, a trip in such a case would require about 15 million years one way.

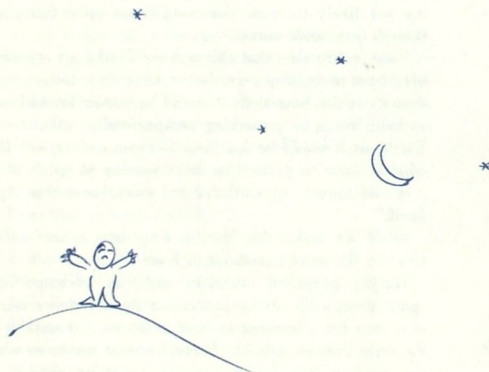
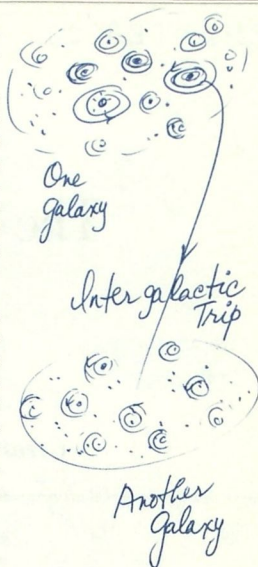
In summary, Earthlings could say that an interplanetary visitor is not to be expected because advanced life does not exist on any of the other planets of Sun's family;



an interstellar visit is not likely because of the vast distance to be covered; and an intergalactic one is completely out of the question.

Earthlings remind themselves, however, that there remains that central possibility of an interstellar visit—in fact of many of them—especially if allowance is made for the fact that life on the Good Earths of other suns may be of a very much longer span than life on Earth. Thus if a life span on a Good Earth of the sun Alpha Centauri, for instance, is one thousand years, it may well be that some enterprising Daniel Boone of space might not mind a journey of 75 years for the purpose of exploration.

Some Earthlings have posed this novel turn to the problem of Space: Must exploration of our Universe be conducted in person? Must we actually propel our bodies through space? Is there nothing more that we can do by means of telescopes, by calculations, by the use of the reasoning power of the human mind? Or, is there nothing we can accomplish by allowing flight to our imagination—a scientific imagination, propelled not by atomic energy but by the power that lies in the human spirit . . . ?



A beam of
light takes
1,600,000 years
from here to the
Planet Earth

The Milky Way

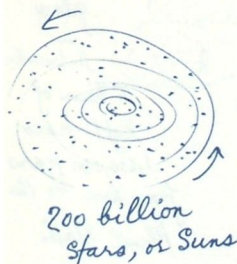
Great cataclysm and expanding universe.

EARTH-PEOPLE have decided that visitors from outer space are not likely to come swarming down upon them, although they *could* come.

"We realize also, that although we Earthlings someday may have space ships, we do not have them today. And even if we did have them it would be just as far and just as long for us to go seeking companions on other Good Earths as it would be for them to come seeking us. But what is there to prevent us from soaring in spirit upon a mental saucer—upward, far and away, faster than light itself."

Shall we make this mental leap into space? Hop aboard; the saucer is about to leave.

Having propelled ourselves and our telescope into space aboard the flying saucers of the mind, we might now stop for a moment to look about us and wonder at the sight that we behold. Surveying vast distances without peering into details, we see about us patches of luminosity in every direction. Most of these are whirling galaxies, each a great collection of one or two hundred billion stars. Each galaxy, shaped perhaps like a pancake, turns about in space at tremendous speed though this is scarcely discernible from our distant vantage point. One complete revolution of a galaxy about its axis takes



perhaps two hundred million years (as it does for our Galaxy), but there are other galaxies which whirl more rapidly, and some less rapidly than this.

We notice on a closer look at these galaxies that in their terrific spinning the edges have been thrown out from the centers, as happens with milk or cream in a centrifuge. At any rate, the edges of the whirling pancakes are not smooth but have great numbers of stars spinning away like the arms of a spiral which is breaking up. Many of these galaxies are, in fact, called "spiral nebulae." There is a theory concerning the connection between the appearance of such a galaxy and its age. If a galaxy is very smooth around the edges, one might suppose that only recently had it begun to whirl, and therefore only recently had it been created. If a galaxy has rough edges, many parts of which are flying away, presumably it was created long ago and has had time to unwind itself. (It is also possible that the galaxy is young but has unwound itself swiftly due to an extraordinary speed in spinning.)

Other things being equal—that is, speed of spinning—the more unwound galaxies are the older ones. According to this view, a galaxy which has existed a really great length of time will have spread out very diffusely, parts of it flying out to great distances.

As we adjust our telescope on our imaginary journey through space, and gaze more closely upon the galaxies about us, we are able to see more detailed structure and even individual stars. Seized with wonder at the myriads of dazzling galaxies about us, we are inspired by these marvels of creation. We are inspired to ponder.

How far do these galaxies extend?

How many of them are there?

Does this go on forever?

How does it come to an end?

Is there an end? And if so, what is beyond?

When did it all begin?

How did it all begin?

Did it ever begin?

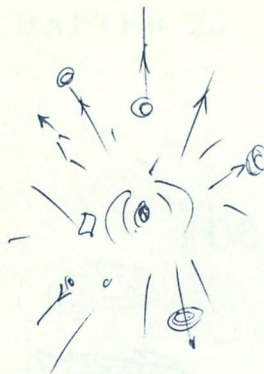
How were the stars formed?

What is their fate? And ours?

What is it all about?

It is not possible to answer all of these questions at the present moment, if ever. We shall be able to answer a number, but it will first be necessary to reach a certain stage in our study where we more clearly understand the meanings of words like "begin," "infinity," "fate," etc.





For the moment, it is possible to state a few facts and proceed from there with at least some understanding of the things which puzzle us. First of all, we can restate that millions of galaxies have been actually photographed and many millions more will be photographed some day when better telescopes are available.

How did the galaxies come into being?

Of course there are a number of theories concerning the origin of galaxies and we shall now take up one or two of these. There is a theory by Abbé LeMaitre, a Belgian scientist and priest, to the effect that it all began with the explosion of one large fat atom which contained all the matter of the Universe. LeMaitre thus starts us on the road to the explanation of galaxies and the Universe as a whole by beginning with one concentrated amount of matter which will disintegrate and give rise to all the material in the Universe.

This original huge atom LeMaitre calls "the primitive atom." Presumably the atom once became unstable or radioactive, and, exploding in a mighty bang, threw pieces of itself throughout all space. These pieces are presumably still hurtling through space, exploding or spinning, or cooling and constituting the galaxies, the stars, the planets, the meteors, and all cosmic matter.

Of course one can immediately ask several questions when this theory is suggested: Are the various galaxies moving away from each other as one would expect them to do according to the Abbé's theory? The answer is, "yes"; as a matter of fact, the Abbé proposed his theory *after* it became known that galaxies are flying away from each other.

Therefore, to emphasize an important point, we may say that today we believe the galaxies are indeed all moving away from each other. The evidence for this belief will shortly be discussed. However, the Abbé's theory still does not explain many questions, among them: What did we have before the primitive atom?

Thus we see that having started on a theory giving an explanation of the origin of the galaxies, we run into more questions. This is not a bad state of affairs inasmuch as our inquiry has excited our curiosity and filled us with wonderment.

Now to take up a second theory, this one originated by the British mathematician-astronomer, Fred Hoyle, and some of his colleagues. According to Hoyle, the galaxies were simply formed from a gaseous material out in space, namely hydrogen. At this particular juncture we will

not inquire into the obvious questions of where did the hydrogen come from and why hydrogen.

To play along with Hoyle for the moment, we need only to inquire as to how the galaxies were formed, and from what sort of material, and whether or not his explanation allows for the apparent action of the galaxies in running away from each other.

Before launching into an explanation of Hoyle's theory, we will stop for a moment to examine in more detail the question of galaxies running away from each other, and how we know this. One might begin about as follows:

If we are standing at a railroad station waiting for an approaching train, we may pass our few moments listening to the high-pitched whistle of the train as it comes rushing toward us. When the train arrives at the station and comes to a halt, the pitch of the whistle will not be so high—assuming that the whistling continues (possibly to accommodate us in our experiment). If now the train departs, gets up speed, and continues to whistle, the pitch of the whistling will be lower than it was when the train was at the station and lower yet, by comparison, than it was upon approaching the station. This sort of phenomenon is called "the Doppler Effect." A certain pitch or frequency sounds higher if the whistle is approaching us (or if we are approaching the whistle) and it sounds lower if the whistle recedes from us (or if we recede from the whistle).

In the case of the galaxies, here is how we apply such observations. We can fix our attention upon some particular color in some galaxy such as the color of a hydrogen "pitch," or frequency, as seen through a spectroscope. Every color of light—such as red, white, or blue—seems to correspond to a certain pitch or frequency. Now, if a particular color's frequency seems lower than normal—that is, lower than it is in our laboratory on Earth—then we might conclude that the color's source is running away from us. This would be the application of the Doppler Effect to the case of light instead of sound.

It happens that the frequencies of the hydrogen color have been measured for a great many galaxies and they do come out to be lower than in the normal case. We therefore might conclude that the galaxies are running away from us and we in turn are running away from them. It is all a relative situation.

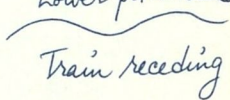
One of the best ways to visualize this running-away process—the "expanding universe" as it is called—is to think of the following: Imagine a black balloon with

pitch heard



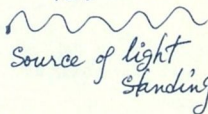
*Train
standing*

Lower pitch heard



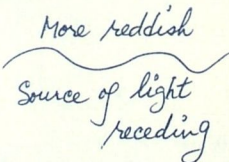
Train receding

Red color

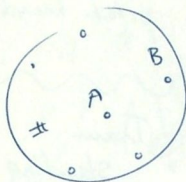


*Source of light
standing*

More reddish



*Source of light
receding*



white spots on it. The balloon is supposed to be the Universe and the spots are the galaxies. Now imagine that the balloon is being blown up larger and larger. Any two galaxies or spots move away from each other. No matter at which spot one stands, all the other spots seem to be moving away.

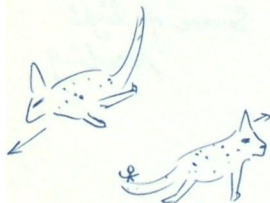
Incidentally, the spots which are further away from the spot where we are will be moving away faster than the spots which are nearer to us. This is quite easy to comprehend; if the two spots were one inch apart they may now be two inches apart, but if two spots were six inches apart they will now be twelve inches apart because all parts of the balloon stretch and contribute to the total increase in distance. We can see therefore that the near spot was moving away at possibly one inch per second whereas the further spot was moving away at six inches per second.

Do we have different rates of separation for the galaxies? Or to put it another way, are the hydrogen frequencies decreased more for some of the galaxies than for others? The answer is "yes" to these questions. The nearer galaxies move away at a certain "slow" rate and the further galaxies are moving away at a "fast" rate if we interpret the evidence of the observations in the manner we have discussed.

But to return to the balloon. Actually, in order to imitate the situation of space we should really visualize a "solid" balloon, let us say a black sponge ball with white spots sprinkled inside of it as well as on the outside. If it were possible now to make this solid ball expand, all the white spots would move away from each other. This is closer to the situation which we describe as the "expanding universe."

It must be pointed out immediately that this expanding of the Universe applies to one *galaxy* relative to another *galaxy*. We are not here talking about *individual stars* in one galaxy. The stars in one particular galaxy may be pretty well held together due to the over-all gravitational effect. Or if they are moving a little bit apart due to that centrifugal action we mentioned before, these speeds would not be very great. It is the movement of an entire galaxy away from another galaxy which is of considerable velocity and can be detected by the Doppler Effect.

The situation is something like that in which one dog with his fleas runs away from another dog with his fleas. Each dog is a galaxy and the galaxies here are moving



apart. The fleas of each dog are the stars and they do not move too much apart from each other, at least not as far as the dogs move from each other, nor as fast.

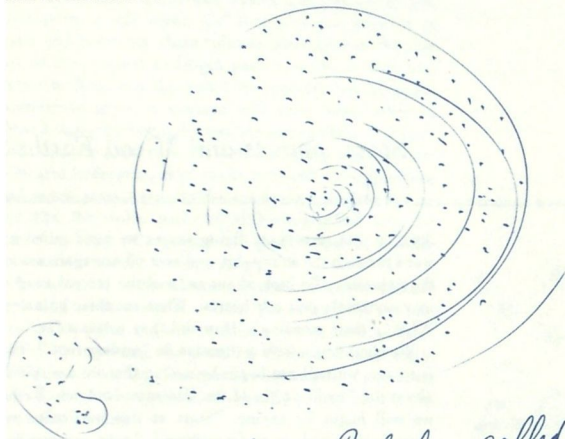
But how is it that we have suddenly left our majestic vantage point among the exciting galaxies and come crashing to Earth to speak of fleeing dogs?

Life encompasses everything.

We may, if we wish, rise again to transport ourselves through space aboard our mental flying saucer—upward to the starry sky above us, and even beyond.

Shall we try?

Thus do imaginative Earth-scientists intrigue us, and lead us onward . . .

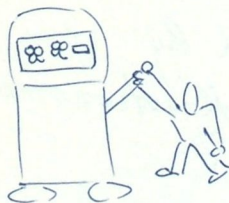


Whirlpool Nebula, called Messier 51
About 6 million light years away from
Galaxy in which Earth lives.

Very rough sketch by
sick Earth-astronomer

The Formation of Galaxies^{*}

Stars, planets and "Good Earths."



ABOARD OUR IMAGINARY flying saucer we have sailed upward through the starry sky, and now we are again among the galaxies. We look about us, and the eternal song of mystery steals into our hearts. What are these galaxies? What is their meaning? How did they originate?

We shall begin with a situation in "mid-current." That is to say, we will not begin by saying that we are talking about the "real" origin of the Universe—not yet. Rather we will begin by saying, "Start at this particular moment in time and go on from there." Later, as promised, we shall indeed make an attempt to "begin at the beginning." For the present, we proceed as follows.

Consider a particular region of space containing nothing but that lightest of all gases, hydrogen. There are no lumps of matter here, but there are, of course, atoms. The atoms of hydrogen are moving erratically, at random, every-which-way. As time passes, some of the atoms congregate in a tiny region of space because of the force of attraction which exists between them. In another spot

**This document was discovered in the pocket of a dazed Earth-astronomer found wandering in the Earth region called "New Mexico," near Las Vegas, where he had been testing his theory of "chance."*

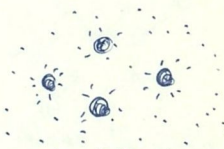
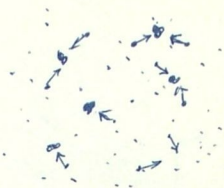
other atoms of hydrogen have congregated and continue to add to their bulk by snaring yet other atoms of hydrogen that bump into them or pass very close to them. In still another region, other groups of hydrogen atoms have congregated, picked up stragglers, and have grown more and more massive as time continues to pass. What we now have is a region in space containing a background of hydrogen gas with localized spots of masses of hydrogen lumps. The larger these lumps of hydrogen grow, the more atoms they catch by gravitational attraction, and the process continues to snow-ball.

As the catching and the growing continue, the lumps turn about, move at random, collect more hydrogen gas, perhaps turn still more, and thus continue growing in mass and revolving about, always remaining in the thin sea of the original hydrogen gas. Clearly, as time continues to flow, and the lumps of concentrated hydrogen continue to grow, a moment will come when some of these lumps may begin to steal the surrounding hydrogen gas at a very great rate. By now we have a mass of concentrated hydrogen gas of really tremendous proportions and as this mass continues to steal the surrounding hydrogen gas, the stolen particles of hydrogen fall into the attracting lump with greater and greater speeds, and the accumulation really becomes large.

As the great lump of concentrated hydrogen gathers more and more material, within the lump itself certain localized smaller regions in turn increase their concentration by capturing the particles which surround them. This type of localized increase in concentration continues throughout the lump mass, eventually giving rise to the formation of stars.

Of course, other large lumps of concentrated hydrogen gas undergo a similar fate and there again galaxies are born out of the original concentrated dark material, and in them, too, further localized concentrations produce stars.

What follows next? In any of these galaxies after its formation, some of the smaller lumps, which are now stars, are blazing at full fury, while some smaller ones are cooling rapidly. Those which are cooling rapidly in a relatively empty space—that is, space devoid of hydrogen gas—will continue to cool and some day die, while others which have been flung into a region where they drift through some of the original type of dark hydrogen gas still have a chance to become prominent. These stars which are drifting through some of the original type of



Localized concentrations becoming stars

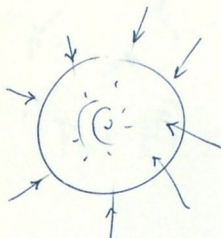
hydrogen gas inevitably capture some of this gas and if a star is very large it will capture a great deal, especially if it drifts slowly through the gas.

Hoyle discusses this type of effect mathematically, showing that under certain conditions, when the mass of the star is large and its drift through the hydrogen gas is slow, a great amount of new gaseous material will be captured by the star and once again the close-gathering process will begin on a very large scale. The falling captured particles of hydrogen gas rain in a flood toward the center of the star and create friction due to the collision that they suffer with parts of the star; the temperature is raised, and the star may then have a sufficient degree of temperature to promote nuclear reaction in which hydrogen gas converts to helium with heat, light, and gamma rays being produced. The temperature of the star then rises due both to the friction heat and the radiant energy which comes from the hydrogen-to-helium nuclear process; possibly the increase in temperature internally is so great that the star explodes. This exploding star when seen from a distance is what the astronomers call a "nova," or a "new one." If the reaction is really extraordinarily violent then the star may be said to have become a "supernova."

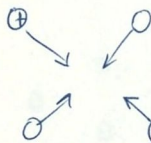
Novas and supernovas are, of course, actually observable throughout space, and, in Hoyle's view, they play an extremely important role in the formation of planets, as we shall see in a moment. We ought to mention at this point that about one or two novas are seen in the heavens per century. While this may seem to be a small number, one must not forget that in the course of billions of years one or two per century can amount to a great many.

Now in what sense are these novas important insofar as the formation of planets is concerned? (Before taking up this subject, we must remind ourselves that we are here stressing only one theory, that of Hoyle.) The stars which we see in the heavens are not all single stars. Many of them, when studied through a telescope, turn out to be double stars—that is, two stars really close together, revolving around each other. These stars form a unit, they belong together, and they never leave each other except in violent celestial events.

Let us assume that one of these stars of the doublet is very large and has caught a great amount of hydrogen gas. This particular star will wind up being a nova or a supernova. It will burst apart shooting portions of itself



*Star growing
large and hot!*



*collision could
result in fusion
& liberation of
much energy*

$$E = mc^2$$

in every direction, perhaps an especially large amount in the direction of its partner, the other star of the doublet. The explosion having taken place, the exploding star will recoil—say in some direction which we may designate as “backward.” This star has shot its bolt, torn itself away from its partner, and is traveling backward away through space, bereft of much of its energy, relatively cool after its violent explosion, traveling, cooling, fading, disappearing, becoming a “white dwarf” or even a dark one.

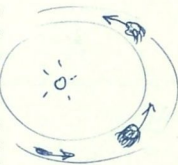
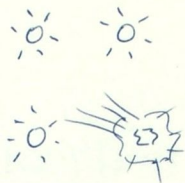
But now to return to the second member of the original doublet. This second star has been left “standing,” facing a barrage of material which came flying in its general direction from its explosive partner who is now no more. The standing star captures some of this material directly; it captures some by bending it into orbits, whereupon the material continues to revolve around the star in an ellipse; and it misses some of the material completely—the part which has passed too far away from it.

The material which has been bent into elliptical orbits eventually coagulates, rounds out, starts to cool, and here we have the beginning of the planets. If all of the material is too far away from this particular star, these planets will be cold and no life will come into existence; if all of the material is too close to the standing star, these planets will be too hot and life again will not come to be. But if some of the material is at an appropriate distance, obviously then, the conditions of temperature at least will be right and if the other conditions are fulfilled—the presence of atmosphere of the right sort and of water—life will come into existence.

The number of such Good Earths to develop, then, is largely determined by these two factors: (1) How many doublet stars there have been in, say, the last four billion years, and (2) How many of these doublet stars had a partner which became a nova.

The first question has a very surprising answer. Today, as we study the heavens, we are quite certain that the number of doublet stars is amazingly large. In fact, every other star that you look at in the sky is really a doublet, and perhaps some day one of these partners will become a nova. Of course we are speaking here of doublet stars which exist today; however, in view of the fact that there are so many doublet stars now, undoubtedly there always have been a very great many doublet stars, and raw material for our calculations is at hand.

We have said that at least one star is seen to become a nova per century and all this permits a kind of rough



*The remnant
of exploding
star has
vanished →
by recoil*

calculation. One star has "novaed" per century; therefore in say four billion years forty million stars have novaed. Twenty million of these had partners. The question then is, how many of the twenty million which novaed and had partners, novaed in the appropriate manner—that is, shooting out material, some of which at least would be caught in an appropriate orbit. Hoyle makes an estimate as to the random firing of material past a star and comes up with a rather conservative figure of at least one hundred thousand portions of material that could have "landed" in appropriate orbits so that Good Earths could develop.

This is what we have said in a previous section; that in Our Galaxy alone, about one hundred thousand Good Earths are to be expected.

When we recall that thousands of galaxies have already been photographed, we can see that it is entirely reasonable to believe in the existence of one hundred thousand Good Earths for each of the one trillion galaxies in our thus-far known Universe, and creatures on them, some without flying saucers, but others undoubtedly with them.

We ourselves have gone aboard the flying saucers of our minds, and, once launched successfully into space, we have decided to study everything that we see, and to wonder about time and space, matter and energy, shapes and forms, and sizes and infinities.

The ordinary saucers were but an unconscious pretext which triggered us into flight aboard the saucers of our spirit, a flight on high where we can pause at leisure to contemplate the Universe and its omnipresent grandeur . . .



Extrasensory Perception

Do other-world beings have it?

EARTH-ASTRONOMERS feel certain that there must exist in space, stars which have cooled to a lukewarmness. These stars are now dark, and could be called "planets."

"Perhaps," some scientific Earthmen say, "we ought to call them 'star-planets'."

On some of these dark star-planets the beings might not have eyes for ordinary "normal" seeing. They might, on the other hand, have perceptive powers that Earth-people do not have.

Touch, smell, taste and the acts of seeing and hearing Earthlings know about.

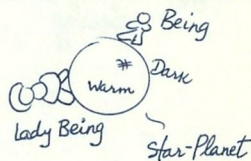
"But," many of them wonder, "could there be other perception mechanisms?"

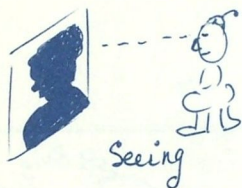
The probability is great that extra-sensory perceptions are possessed by various kinds of beings.

What would they perceive?

"The thoughts of others, perhaps," say some Earth-scientists. "Or consider birds on the wing who seem to 'perceive' their whereabouts and know how to return home, over great unknown distances; and fish know where to go for old times' reunion . . ."

"And CATS," someone interjects suddenly, "CATS KNOW HOW TO RETURN TO PLACES THEY LIKE FROM FAR, FAR AWAY."





Magnetic waves, electric waves, cosmic rays—these are not perceivable by Earth-people, except when they use instruments. Are there beings who can perceive these energies with their bodies?

Many experiments have been conducted by Earth-scientists on ESP. For example, Earthlings have been tested on naming the cards lying face-down on a table. This is called "clairvoyance," or "clear-seeing." If there are five of each kind of card, and if the 25 are shuffled and placed face-down, what is the expectation of success in guessing? One should expect five correct hits out of 25. If, for many trials, an Earthling consistently guesses six or seven out of 25, there is "more than *chance* operating."

There have been such Earth-people, who have made such high guesses for years.

In another variation of clairvoyant testing, five key cards are face up, and a complete deck is face down. The Earthling is to gaze at the back of the deck, "see" the first card, and place it under the corresponding key card.

The "Blind Matching" test consists of the same situation as above, except that the key cards also are face down.

In the "Single Card Calling" test, the entire deck is face down. The subject calls the cards, one by one, removes each and places it aside still face-down, while the operator keeps the score.

In the "Pack Calling" test, the subject calls all 25 cards without touching the face-down deck. Presumably, here he is testing his ability to see deep into the deck through a bunch of cards already called.

All these are clairvoyance tests and several professors claim they have had successful subjects for them. Dr. Rhine at Duke University and Doctors Schneider and Murphy at Harvard University are three of the conductors of such tests.

Another type of test is, of course, that for "telepathy." In this case, without any cards or other props, a subject attempts to read another's mind.

The person who is to send a message might look at a card; the receiver, or percipient, then "reads" the sender's mind, or receives his thought.

In "distance telepathy," the percipient may be in another building, or even across some ocean.

Another phase of this type of awareness is the kind in which the percipient "looks into the future." This is described by Earthlings as "second sight." It is called "precognition."

In the test, the sensitive subject guesses *ahead of time*

how cards will shuffle. If this were reliable, some Earthlings who indulge in a sport called "poker" could have an interesting (and profitable) time.

Still another form of extrasensory activity is that in which the subject, by *wishing*, makes an inanimate object do his bidding. For example, an Earth-person rolling dice may wish hard, as they roll, to have them come up a seven. And, presumably, his intent wishing turns the dice. This is called "psychokinesis." Other Earthlings call it "loaded dice"—which may be an unfair remark.

Do any of these phenomena really occur?

Much wrangling takes place about this whole question. Some critics of ESP plainly accuse certain investigators of fraud. Others are less harsh. Still others believe.

There is no doubt about one thing: Many phenomena that Earthlings encounter are not clear to them, but remain mysterious. Also, much behavior of the lower animals and insects seems to some Earth-scientists like ESP.

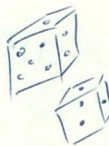
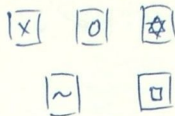
"If no living beings on Earth really have ESP powers," says one scientist, "it nevertheless is possible, even probable, that on other planets, on other worlds, phenomena like ESP are common, or even normal."

"The Universe," says another scientist, "is large. The varieties of life, experience, combinations of elements and circumstances are almost unlimited. Therefore, on the dark star-planets, on a moon of Jupiter, or on a remote planet of a distant galaxy, there could exist other kinds of beings, with other kinds of powers—powers of awareness, of communication, of volition. We on Earth may, unknowingly, have such beings near us, about us. We may even be such beings, in part, ourselves."

"The homing instinct," one remarks, "the silent 'conversation' of animals, the exchange of understanding between a Cat and an Earth-man, the hypnotists, mental prodigies, geniuses, inspired human beings . . . what exactly are they?"

Do "brain waves" exist? Is there such a thing as genuine automatic writing? Is premonition a fact?

Earthlings today know much. But not very much . . .

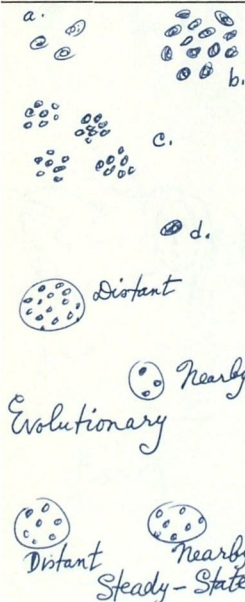


"Come
on,
Earth-
baby!"



Astronomy in the Dark

Collision—all heaven breaks loose!



GALAXIES ARE ISLAND UNIVERSES, and each, as we have seen, may consist of some 200 billion suns.

Galaxies are found in:

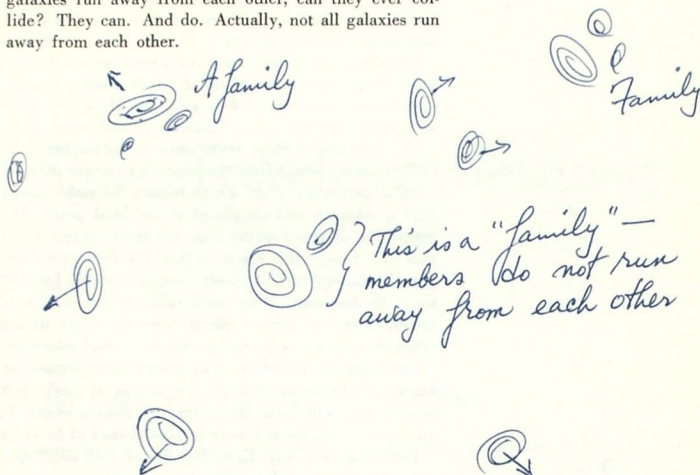
- a.) small groups
- b.) large clusters
- c.) clusters of clusters
- d.) alone in wide lonesome space

"If the Universe is 'evolutionary'," reason some Earth-astronomers, "it perhaps originated in a BANG! and the pieces—which became galaxies—are still running away from each other. Thus, the expanding Universe. If this is so, then a view of distant space, giving a picture of how things were long ago—since the light which reaches Earth from distant space must have left long ago—should reveal *more* galaxies in a given volume than a view of nearby space. This would be so, because a view of nearby space gives a view of a recent situation.

"But if the Universe is a *steady-state*—as galaxies run away from each other, new galaxies are formed in the 'emptiness' out of hydrogen gas—then views of distant and nearby spaces should look the same."

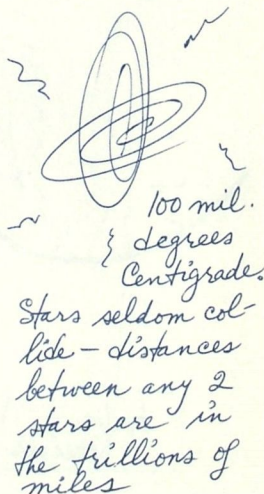
The findings of Earth-astronomers are not conclusive as yet on this matter.

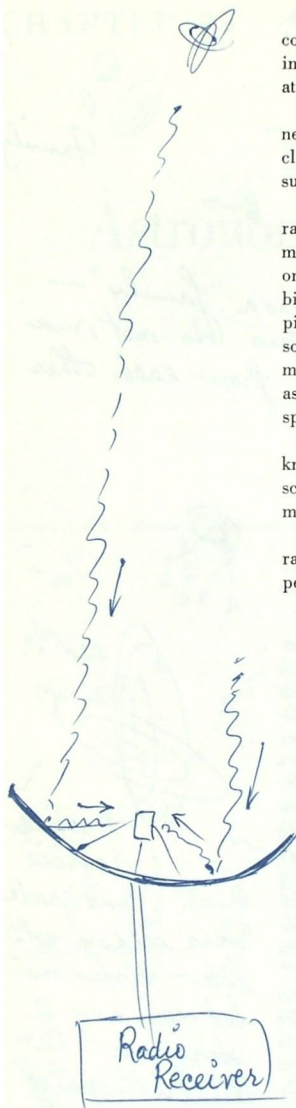
Since, in any case, the Universe is expanding and the galaxies run away from each other, can they ever collide? They can. And do. Actually, not all galaxies run away from each other.



Families run away from other families (or from singles). So, in general, galaxies do run away from each other. But members of one family may collide with each other. And when they do, all heaven breaks loose! Billions of stars with their planets interpenetrate other billions with their families. Loose space dust and gases collide; friction gives rise to bursting heat and light; and swarms of accelerating electrons give rise to electromagnetic energy of long wave length which radiates into all space. One of the strongest emitters of radio energy is called "Cygnus A," which is near the constellation Lyra—easily visible in the Northern Hemisphere. Another spot of vigorous galactic collision is in the constellation of Cassiopaea, opposite Ursa Major—across the North Pole.

Planet Earth receives its share of energy in the form of radio waves from such galaxies in collision. The amount of energy radiated by the Cygnus galaxies in collision is so great that if it were *all* caught for just one second, it would be great enough to supply all of Earthlings' needs for one trillion years.





Radio waves reach Earth, not only from galaxies in collision, but also from exploding stars or excited gases in free space, and from lightninglike disturbances in the atmospheres of such planets as Jupiter, Mars and Venus.

The distant disturbed areas which send out electromagnetic energy are in general called "radio stars"—though, clearly, they may be colliding galaxies. More than 2000 such radio stars have been detected by Earth scientists.

The detection of these radio waves is accomplished by radio receiver equipment, the antenna generally being a metallic parabolic "dish" which focuses the radio energy onto a sensitive pick-up placed at the focal point. The bigger the diameter of the dish, the more energy it can pick up. Some dishes are more than 200 feet across, and soon Earthlings will be constructing dishes 600 feet and more in diameter. With such radio telescopes Earth-astronomers can receive effects from far more distant space than they can by using ordinary *visual* telescopes.

Earth-people, therefore, will search their distant unknown Universe increasingly by means of radio telescopes, and will infer the nature of distant events by measuring energies and wave lengths instead of by sight.

Here, one could say, Earthlings armed with adjuncts—radio telescopes—behave like beings with extra-sensory perception.

Space Travel and Relativity

Fourth dimension—a fountain of youth.

DR. ALBERT EINSTEIN'S Theory of Relativity has a great many important implications for Earthlings as they start out on that most majestic adventure—the exploration of space.

Einstein's Theory says a lot of things that Earth-people find difficult to believe, although the theory has been confirmed. For example, the Theory says it is possible to convert substance into energy. This was confirmed—unfortunately the hard way—over Hiroshima and Nagasaki. Also, the Theory states that a beam of light which passes near a massive celestial body will be bent. This, too, has been confirmed—and is reconfirmed with measurements made during eclipses of the sun.

The most intriguing of Einstein's predictions, and the one which will be most important to space exploration, is this: If an object moves away from Earth, time on that object will run more slowly than on Earth. The greater the object's speed, the more will time slow down.

It has been proposed by Earth scientists that a satellite be launched with a radio clock inside, so that the time difference could actually be measured. The lag might be only, say, .001 second in three months, but this could be measured accurately. Such an experiment will soon be performed.



Let's see how these ideas of Einstein's bear on plans for space travel. Is it "practical" to talk about a journey to another solar system? The distance to the nearest neighboring sun, Alpha Centauri, is about 25 trillion miles. Dare Earth inhabitants even contemplate such a journey? After all, the distance to the farthest planet (Pluto) of their own solar family is 3.5 billion miles. Alpha Centauri is *7000 times* farther. Our space traveler would have to take along a good many bottles of medicine for "tired blood" to keep him alert and peppy.

Suppose Earthlings dare raise the question of traveling even farther—to the end of their galaxy. This distance is 25,000 times greater than the distance to Alpha Centauri (25,000 times 25 trillion miles, or 625,000,000,000,000 miles). If they tried this trip at 100,000 miles per hour, it would take about 900,000,000 years. Clearly, even the most hardy among them would find it difficult to arrive in good shape no matter how they fortified themselves with vitamin B complex.

But, according to the Theory of Relativity, it may be possible to make such trips. In the first place, Earthlings don't have to travel at only 100,000 miles per hour. Why not speeds of 100,000 miles *per second*? They should be able to achieve such speeds through applications of nuclear energy. But that is not the only encouraging feature. The Theory of Relativity states that if tremendous speeds are attainable—speeds which approach the speed of light (186,000 miles per second)—then *time* on the spaceliner will run appreciably more slowly than Earth time. While one million years elapses on Earth, for example, a space man traveling near the speed of light may grow only five years older. Not only his wristwatch, but his body cells, circulation, everything will slow down so *he actually will be only a few years older when he returns!*

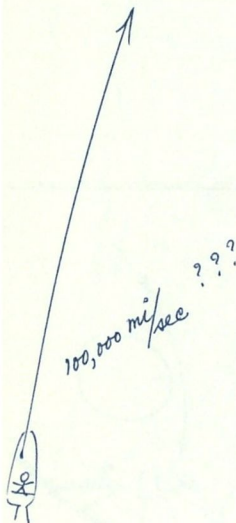
It is impossible for material objects to attain the speed of light. However, they can reach speeds *almost* equal to the speed of light, and *almost* not age at all as they course through majestic celestial space.

Now how does all this come about?

Let us see how the great Earth-scientist came upon these conclusions.

There is a story told on Earth about two workmen riding home in a subway train after work. One man is resting, occasionally dozing, the other is reading a newspaper. The alert one speaks.

"Hey, Joe. Joe! I see where Einstein is going to Brazil."



"Huh? Where?"

"Brazil. Einstein's going there."

"He is?"

"Yeh. You know, Einstein . . ."

"Yeh, I know him. Where is he going?"

"He's going to Brazil."

"Brazil? Why?"

"Just a minute, Joe. Let me read a little more."

"Yeah."

"Here it is—it's about the Theory of Relativity."

"Oh, yeh. What about it?"

"Well . . . You know, the Theory of Relativity, Joe . . . You know . . ."

"Uh huh. I . . . I used to know it. What is it?"

"The Theory of Relativity?"

"Yeh."

"Well—Joe. You know. See, it's like this. If a man sits on a hot stove, then one second might seem like an hour. But if he is making love to a beautiful woman, one hour might seem like a second. See, Joe?"

"Yeh. For this kind of stuff Einstein has to go to Brazil?"

Einstein did not go to Brazil. But other scientists made the trip to observe an eclipse of the sun during which it would be possible to check on the Theory of Relativity.

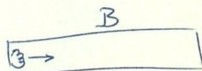
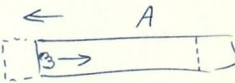
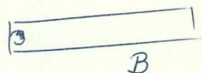
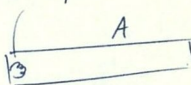
But that was for the so-called "General Theory of Relativity." First, in 1905, came Einstein's basic notions regarding space and time.

Consider two trains in empty space, far away from all stars and planets. Each train contains a lamp at one end. The trains are as shown, with a man named "A" in train A, and a man named "B" in train B.

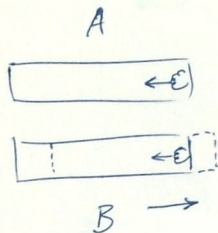
Supposing B looks out and says, "Oh! A's train is moving to the left. I think I will now do an experiment. I will measure the *length* of A's train, by observing our two rays of light traveling to the right. I know already that as the front end—left—of A's train moves further left, the back end will also move left. And therefore the ray of light in A's train will complete its journey before the ray of light in my train completes its journey. But since both rays of light travel at 186,000 miles per second, the earlier completion of the journey in A can only mean that A's train is now shorter than mine, because of its motion."

One might wish to protest that if A's train is moving to the left, isn't the ray of light sort of held back by this amount—that is, isn't the speed of light in A's train really

a lamp



B says, "A is going away."



A says, "B is
going away."

smaller than in B's? The answer, of course, is, "No."

It is an experimental fact that the speed of light (in vacuum or in air) is always the same, regardless of whether the lamp emitting the light is carried away from an observer, or toward the observer; whether the observer moves toward the lamp, etc. The speed of light is *constant*, 186,000 miles per second, and independent of the relative velocity of the source and the observer.

This, of course, is startling right off the bat, and hard to understand. But that's it. If we want to make progress, we'll just accept the *fact*.

Now. The traveler, A, as a matter of fact, might have looked out of his train! What would he have seen? He would have said, "Oh! B's train is moving. I think I will figure out who's train is longer. I am thinking about the two rays shown—about their journeys. It is clear to me that since B's rear end is moving up, the ray in B's train will complete its journey earlier; and since both rays travel at the *same* speed, B's train must be shorter when it is moving, than mine."

"But I am not even moving!" B protests. "You are moving . . ."

And so it goes; who is moving? We know of *relative* motion only. And the proper conclusion is this: A person who measures the length of his own "train"—house, yard, table—will get one answer. But another person who has a *relative* motion with respect to the first (along the dimension to be measured) will get another answer. Who is right? Both are right, unless they claim the other is wrong. Length is not a thing. Length is a measurement. It is improper to say that a body "has" a length, like a dog "has" fleas. The dog really *has* them, and they keep him and themselves hopping. A body does not "have" a length. A body is *measured*, by somebody. And various answers all may rightly result, depending upon the relative velocity of the body and the measurer. Length is a relative concept.

But isn't there one really *correct* length? For example, the length which I obtain for this table which is at rest on Earth? Say it comes out five feet. That's it! isn't it?

A Martian would say, "The planet Earth is moving with respect to me. An Earthling there has just measured the length of his table. He thinks he has the *real* answer. He thinks that he and his table are 'at rest.' Doesn't he know that the whole planet Earth, the table and he himself are all moving? Ha! I just measured the length of his table by sightings from here. I get a little less than

five feet. I get the right answer. I am standing still."

Is he?

Who is "standing still" in space?

There are only relative positions, relative motions and relative lengths.

There is no "standing-still" point in the Universe, which might be taken as the point of reference for obtaining the "truly right answers" in the measurement of length. There is no "hitching post" in the Universe, where an Earth-man may hitch his Earth-horse, and say, "This point is it, bub." And the same sort of thing happens with time.

Consider the two trains again: B looks out and sees that A's train is moving to the left.

"I will see how rays of light behave now in A's train. Those two rays from the lamp hanging down in the middle of A's train would reach the two ends of A's train simultaneously if it were not moving. But now that it is moving, clearly the ray traveling to the right will strike its wall before the ray traveling to the left strikes its wall. So A does not now have simultaneity. Of course, I, who am not moving, still have simultaneity."

A says, "Nuts." (Earth-nuts, of course.) "I am not moving. *You* are moving. *You* don't have simultaneity. I do."

And, as before, the correct statement is: "Simultaneity is a relative concept. The passage of time, or duration, is relative, depending upon the relative velocity of the 'train' where the time lapse is occurring and the measurer."

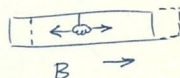
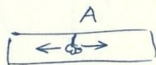
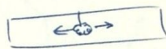
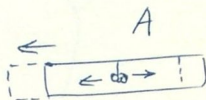
There is no *absolute* time in the physical sense. The time-lapse between two events can be anything, depending on the situation, conditions, circumstance . . .

Thus, time flow has a different rhythm when judged or measured by different "reference systems." An Earth-man traveling at a great speed—as judged by Earth—out into space does not age as rapidly as his friends do on Earth. Here lies the fountain of youth.

If a pair of ten-year-old twins were to separate, one traveling to a distant solar system at a great velocity (judged by Earth), while the other remained at home, the traveler would age slowly, biologically, while the stay-at-home aged "normally."

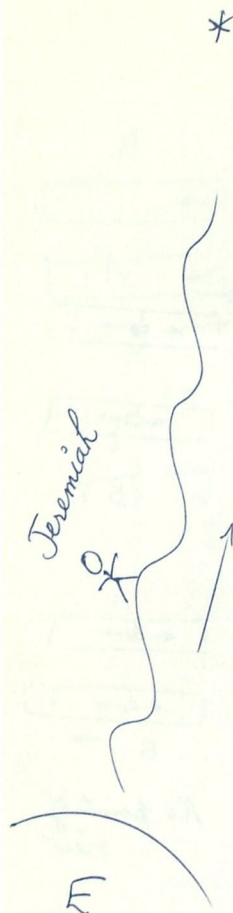
The traveler might reach a distant haven after five years (for him), while on Earth forty years might have elapsed.

On the return journey at the same speed, things do *not* cancel out, as some Earth-people believe. The same



A's point of view





effect as before takes place. The traveler ages another five years, while the stay-at-home ages another forty years. When the twins are reunited, one would be twenty years old and the other would be ninety. There is a temptation to draw a moral—stay-at-homes grow old, fast-travelers stay young . . .

Of course, someone is sure to call out, "But listen! Couldn't we have assumed that it was the *Earth* which moved away, and the rocket stood still—as with all that jazz about *A* and *B*—remember?"

The situation is *not* like it was with *A* and *B*. In their case, there was perfect symmetry. One couldn't *tell* who was moving. In fact, the question of "*who* is moving?" was meaningless. There was only relative motion. But in the twin bit, it's different. We *know* who is moving. The twin in the rocket feels an acceleration at take-off. Starlight comes to him now with a new Doppler Effect; he feels an acceleration at take-off; and he feels a deceleration upon touch-down on Earth. He's been traveling, this flying Earth-boy! He's been way out. He's young. The Earth-boy at home feels nothing, but age. Anyone for space?

How much slowing down of time does occur? The faster the travel, the more the slowing down. If a person could travel with the speed of light, he would not age at all. On Earth, people could say, "Jeremiah is traveling on a ray of light toward the sun Alpha Centauri. By our reckoning, he will get there in 4.3 years." That is by *their* reckoning. By Jeremiah's reckoning no time elapses at all. In fact, he can't even reckon—that takes time, doesn't it? Jeremiah might go around the Universe in *no* time. Talk about *Around the World in 80 Days*; here is "Around the Universe In No Time At All."

But. But Jeremiah wouldn't be *living*. He would have an eternal frozen moment-on-a-sunbeam. The cure for this is—don't travel quite that fast. *Let* some time elapse, *live* it up.

Besides, a material object cannot travel with the speed of light. But it can travel with *almost* the speed of light—which is pretty fast, too.

Sometimes, in their enthusiasm, Earthlings go even further, and ask what would happen if they could travel *faster* than the speed of light? Would time run backwards? Would one outrun the light rays traveling through space which carry the images of the strutting Napoleon, of Caesar?

This is going on already. We *are* looking into the past.

Not only a few thousand years into the past, but millions of years into the past. And this is no joke, and no trick. Except that the past that we see is not our own. It is the past of other Worlds.

When Chinese astronomers saw a star flare up in the sky on July 4, 1054 A.D.—that event actually occurred ages and ages earlier; the light images took a long time to reach the planet Earth. When Earthlings look at the Galaxy in Andromeda, what they see occurring is a *past*, 1.6 million years old. The present is yet to come—in another 1.6 million years.

But Earthlings cannot look into their own past. Still, it is intriguing that everything they see, out of their world, is from the past. Only at home, close at hand, are they aware of the present.

Nevertheless, some scientific enthusiast and poet wrote about an Earthling who had extraordinary speed:

There was a young lady named Bright,
Who could travel much faster than light.
She departed one day,
In a relative way,
And returned the previous night.

How much slowing down of time occurs for a space traveler? Here is Einstein's finding:

$$T_2 = T_1 \sqrt{1 - \frac{V^2}{C^2}}$$

T_1 is the time elapsed on *Earth*, while a traveler in a space ship experiences a lapse of time T_2 ; V is the velocity of the space-ship relative to Earth, and C is the velocity of light.

Let us, for example, assume that the traveler is speeding away with nine-tenths the speed of light; let us say he has been traveling for 100 years as judged on Earth. Then:

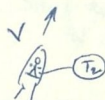
$$\begin{aligned} T_2 &= 100 \sqrt{1 - (.9)^2} \\ T_2 &= 100 \sqrt{1 - .81} \end{aligned}$$

Approximately,

$$\begin{aligned} T_2 &= 100 \sqrt{.2} \\ T_2 &= 50 \text{ years.} \end{aligned}$$

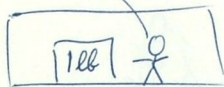
So, while on Earth 100 years have elapsed, for the traveler only 50 years have passed.

We could have given such a formula for the *length* problem, likewise.



$$L_2 = L_1 \sqrt{1 - \frac{V^2}{C^2}}$$

"This is one pound."



"No!"

Can some Earth-reader figure out how long a spaceship traveling at 1,000,000 miles per hour would appear to be to an observer on Earth if a traveler on it said, "My spaceship is 1000 feet long"?

Incidentally, Einstein's Theory also has something to say about *mass*.

How about a moving mass? When a 100-pound sack of Earth-potatoes (are there other kinds?) is placed on a train, the Earthling who watches it move away would calculate that it is now more than 100 pounds. (This may give ideas to Earth-butchers, who might weigh out "traveling meat" while they and the customers stand at the track, then whisk it off and sell it.)

Here is the relation, if M_0 is the mass at rest relative to the observer and M is the mass as measured when it is moving:

$$M = \frac{M_0}{\sqrt{1 - \frac{V^2}{C^2}}}$$

Moreover, Einstein also said that mass could vanish utterly—without a trace of ashes, smoke, debris. It could convert completely into pure energy (light, X-rays, gamma rays). And, of course, Earthlings have accomplished this already in nuclear reactors, Uranium, Plutonium and Hydrogen Bombs, and countless nuclear experiments:

$$E = MC^2$$

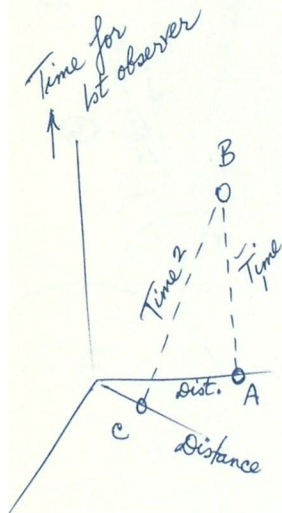
where E is the energy, M is the mass which vanishes, and C is the velocity of light. If M is 1 gram, then:

$$\begin{aligned} E &= 1 \times (3 \times 10^{10})^2 \\ &\text{or} \\ E &= 9 \times 10^{20} \text{ ergs} \end{aligned}$$

But to return for a moment to length and time.

Length is relative, we said. We ought to say, of course, so is width and height. We should say, better, "distance" or "space" is relative. And, of course, the lapse of time is relative.

We might show something interesting and perhaps unexpected: OA is a distance as measured by one observer. Say he was measuring the length of a city block. AB is a time as measured by the same observer—perhaps the time for this observer to casually measure off the city block.



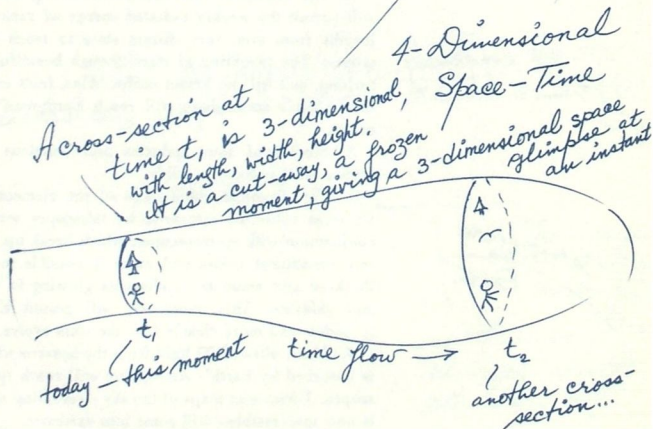
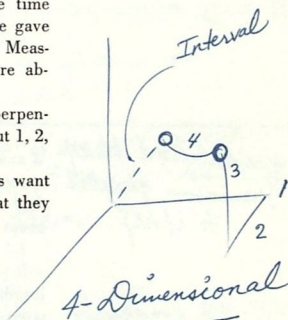
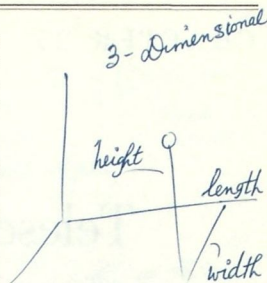
Let OC be the length which another observer gets for the same city block. The second observer has a velocity (along the length of the block) relative to the first observer. CB represents the time elapsed as measured by the second observer.

So OA and OC are different; AB and CB are different. But it can be shown that both observers would agree on something! They would agree that OB is the same! OB is a composite of distance and time—or, of space and time. OB is not a length; it is not a duration. It is called "interval." Interval is an absolute. All observers, no matter how they move with constant velocity relative to each other—Earthlings, Martians, Spacelings—all would calculate the same Interval. Space is relative, time is relative, but space-time, or Interval, is absolute.

Space, of course, is not just length. Someone should really think of three space dimensions and one time dimension. And this is what Einstein welded. He gave Earthlings a four-dimensional world, space-time. Measurements made in a four-dimensional segment are absolute, something that all observers agree about.

The four dimensions are thought of as being perpendicular to each other. Observers may disagree about 1, 2, 3, or 4; but they agree about Interval.

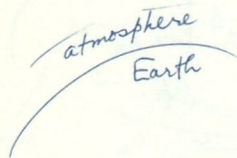
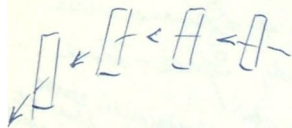
So, time is the fourth dimension. If Earthlings want an intelligible non-capricious Universe, that's what they must accept.



Telescopes in Space

A peek in flight.

*gyro-stabilized telescope
remains parallel
to itself*



WHEN EARTH-PEOPLE establish powerful telescopes in space—in satellites, on space platforms, on the Moon—they will learn a great deal more about the Universe about them:

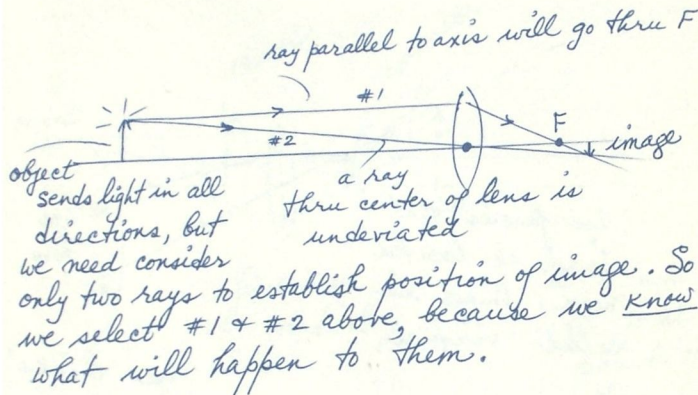
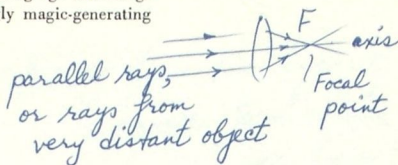
1.) The elimination of Earth's absorbing atmosphere will permit the weakly radiated energy of various wave lengths from even very distant stars to reach the telescopes. The twinkling of stars, though beautiful, is disturbing, and will no longer occur. Also, faint extensions of the sun's atmosphere will reach Earth-man's instruments.

2.) Studies of faint galaxies and nebulous gaseous regions will become possible.

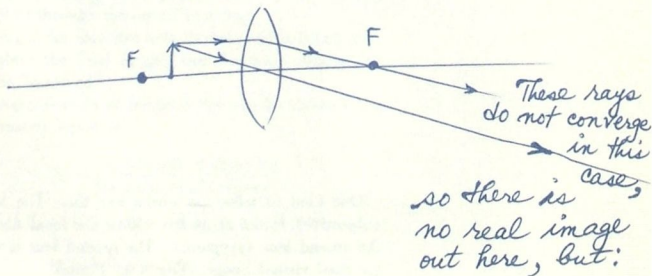
3.) The chemical abundances of the elements in the Universe could be measured by telescopes working in conjunction with spectroscopes, which break up the light into constituent colors and make it possible to identify the kind and amounts of elements glowing in the stars and galaxies. This, moreover, will permit Earthlings to understand more clearly how the stars evolve.

4.) Much ultra-violet light from the heavens which now is absorbed by Earth's atmosphere will reach space telescopes. Ultraviolet maps of the sky—revealing much that is now inaccessible—will come into existence.

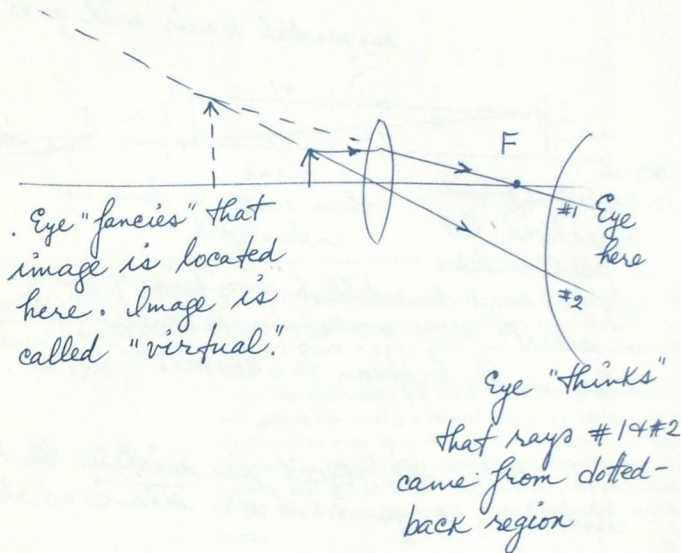
How do visual telescopes work? Long ago Earthlings learned the secrets of these seemingly magic-generating instruments:



When the object is within the Focal distance, rays #1 & #2 behave as shown:

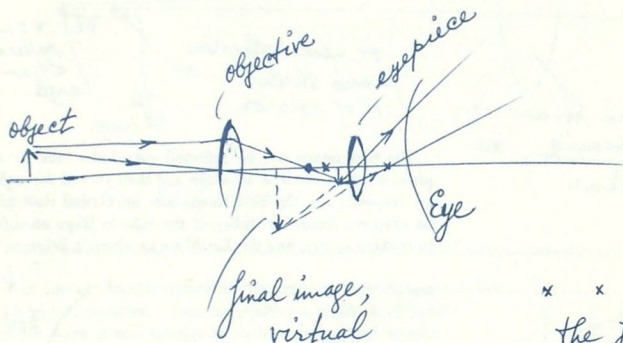


If an Earthling places his eye as shown, he will see something:



One kind of telescope works like this: The first lens (objective) forms an image *within* the focal distance of the second lens (eyepiece). The second lens now forms the final virtual image. That's it. Period.

So, combining the two types of image formations, we have:



x x are
the focal
points of
the
eyepiece

This is a "refracting" telescope. The light rays are refracted, or bent, as they pass through a lens—except if they pass through the center of a lens.

The larger the objective lens, the more light is gathered, the brighter the final image, and the more clearly can details be "resolved."

The *magnification* of the telescope can be shown to be approximately equal to

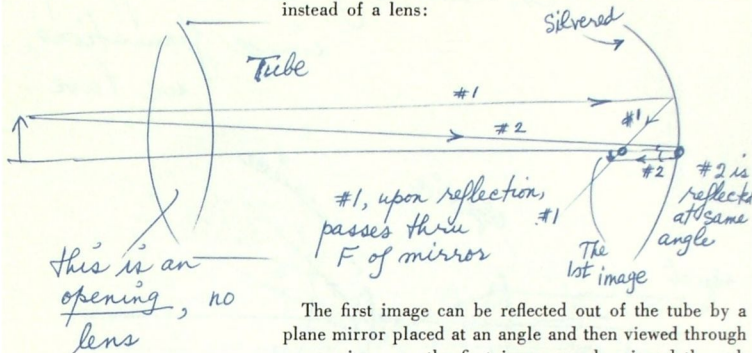
$$M = \frac{\text{focal length of objective}}{\text{focal length of eyepiece}}$$

Thus, if F_o is 100 inches and F_e is a half inch,

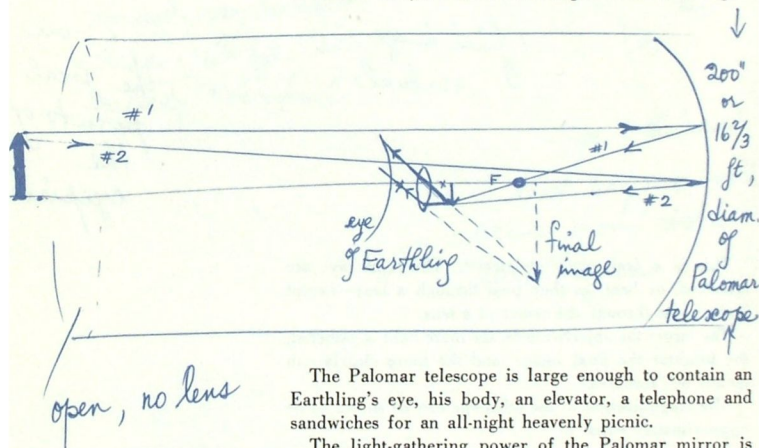
$$M = \frac{100}{\frac{1}{2}} \rightarrow 200$$

Other eyepieces may be used with the same objective lens (which is usually permanently installed), and thus various magnifications may be achieved.

Another type of telescope uses a mirror as an objective instead of a lens:



The first image can be reflected out of the tube by a plane mirror placed at an angle and then viewed through an eyepiece; or, the first image can be viewed through an eyepiece *inside* the tube—if the tube is large enough to contain an eye, and the Earthling to whom it belongs:



The Palomar telescope is large enough to contain an Earthling's eye, his body, an elevator, a telephone and sandwiches for an all-night heavenly picnic.

The light-gathering power of the Palomar mirror is equal to 700,000 pairs of eyes of Earth people. The mirror, and the whole telescope, is called "The Big Eye." The glass mirror, weighing $14\frac{1}{2}$ tons, is "silvered" on the concave surface with just one ounce of aluminum coating and brings the Universe to Earthlings in Southern California.

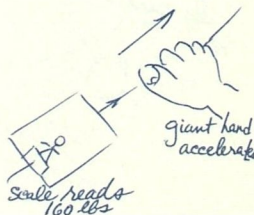
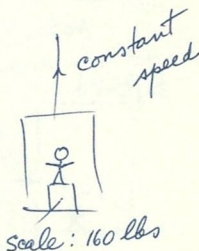
General Theory of Relativity

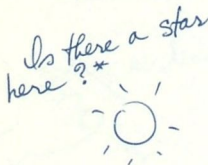
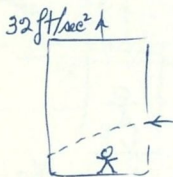
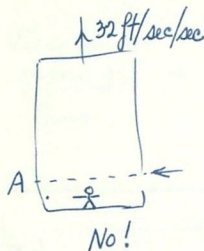
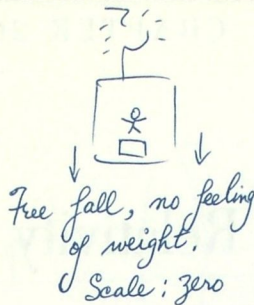
The unified field theory.

THE GREAT EARTH-SCIENTIST Einstein, in his Special Theory of Relativity, took up problems in which objects either were at rest relative to each other, or had relative straight-line motions at constant speeds. But, of course, objects might have *accelerated* motions in straight lines, or they might travel in curves.

Einstein thought about these questions, and here also his mind found unexpected scientific pathways. Einstein liked to imagine experiments—particularly experiments with little elevators:

If an elevator near the surface of Earth is rising at any constant speed in a straight line, or is at rest, an Earth-man inside weighs his normal weight. In fact, he won't know that he is moving at constant speed—if he is—unless he looks out the window. And, as a matter of fact, if he were in the elevator far, far out in space where Earth's gravity is negligible, and the elevator's speed were being increased at the rate of 32 feet per second every second, the traveler's weight would be the same as it was on Earth. And he would not know whether he were being accelerated through free space, or moving with constant velocity near Earth, or even at rest on Earth. In fact, thinking he is at home on Earth, he might open the door and step out!





So, here we have acceleration being equivalent to gravitation.

And, conversely, on Earth, if the elevator cables had broken, the man would fall freely with the elevator and the scales, and he would weigh nothing—until he struck Earth.

So in yielding to gravity and indulging in accelerated free fall, one can eliminate gravity. Or, as we have seen, the introduction of acceleration can simulate gravity.

"Acceleration," said Einstein, "is equivalent to gravitation. And, conversely, gravitation is equivalent to acceleration." This is called "The Principle of Equivalence."

Acceleration $\rightleftharpoons$ Gravity

Next, Einstein thought of this experiment: Supposing a beam of light enters through a hole in the side of an elevator which is in free space, but which is accelerating at 32 ft/sec/sec.

What would an observer inside see? Since the elevator is rising while the light is crossing inside, the beam would strike the back wall not at a point *A*, but at some point lower down on the back wall. An observer riding along would see the course of the light beam as arched. We who are outside would say, "This particular arching is the result of the elevator's acceleration in the far-away distant space."

But the rider might even think that he is on Earth! His weight is normal. So, he might say, "A beam of light passing near Earth, or any body, will be arched, or deflected, by the body's gravity."

Einstein said, "Why don't we see if this is actually so? Does a body like Earth or the Sun deflect a beam of light—say starlight? The Principle of Equivalence leads to this conclusion."

Einstein explained how the test might be made: The Sun is a rather massive body with a large gravitational effect, especially near it. If a beam of starlight should pass near the surface of the Sun, the starlight should be deflected—and by a definite amount, which can be calculated. But how can we see stars and their light when the Sun is shining? The thing to do is to keep the Sun in the way, but don't let it shine. Eclipse! Wait for the Moon to shut out the Sun's light which floods our eyes, then look for some star whose beam may be passing near the darkened Sun.

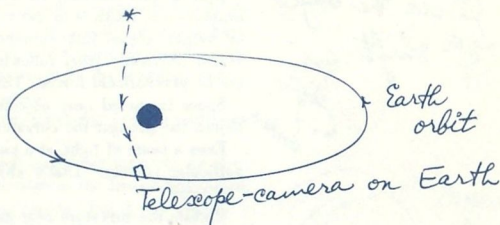
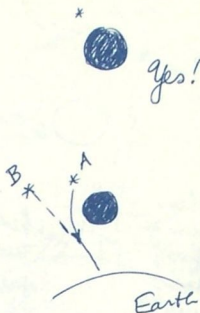
But another thing must be done, because how do we

know the starlight was deflected? Maybe the star is at B anyway, and not really at A .

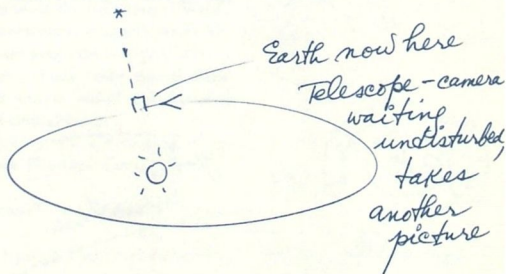
It was clear that the same star's direction relative to Earth would have to be determined when the Sun was elsewhere, far away.

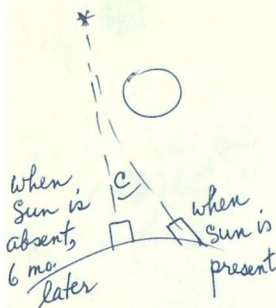
Einstein explained the whole bit. Take an eclipse picture, locate stars on the photographic plate. Leave the camera alone, wait for six months, then take another picture. Compare the positions of the star images.

And so two expeditions set out to make the pictures, one going to South America, the other to Africa. The two sets of pictures, six months apart, were made. The images had shifted by the anticipated amount. Einstein was right.



Then, 6 months later

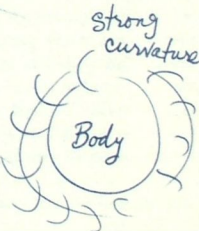
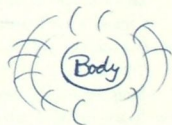




C is the angle of shift



gentle curvature



It must be said that even in Newton's ordinary gravitational theory, deflection of the beam of light is expected—but not as much as in Einstein's theory. His theory demands twice as much deflection as Newton's. The experimental results support Einstein.

Einstein said, "There is no such thing as a *force* of gravity. There is only this: Every object, like a Sun or planet, does something to the space around it—it 'curves' the space, or distorts it, or makes contours in it. And an object like a falling rock is simply traveling along an appropriate contour. Appropriate to its distance from Earth and the velocity, if any, with which it was projected."

Einstein calculated the nature of these contours and showed that bodies would not travel quite as Newton's theory would require them. Confirmation followed.

Even a man standing on Earth is trying to follow a contour—but Earth is in the way. Gravitational feeling, or weight, comes into existence when bodies are prevented physically from following their contours. There are no gravitational forces. There is no mystery.

Space is curved near objects. The more massive the object, the stronger the curvature.

Even a beam of light, at a particular distance, finds its particular contour. That's why Einstein's starlight was "deflected."

Besides the curvature near each body, the presence of all the bodies in the known Universe produces a *general* space curvature, in addition to the "local" curvatures. Thus, space is slightly curved in general, and strongly curved near massive bodies.

A beam of light, then, starting from Earth, might travel along the Universe's curvature and might return home, some day.

This is part of Einstein's *General Theory of Relativity*. Einstein also spent many years thinking about the "force" of magnetism, and about electrical "force."

He thought that these were not actually forces. He said, in effect, "A magnetic pole distorts the space about it; the pole curves the space; it makes pathways for magnetic substances. And an electrical charge 'curves' the space around it with an electrical curvature . . ."

Thus, only a matter particle "knows" that pathways or curvature exist around a matter body.

Pure electrical or magnetic particles without mass would not fall toward a matter body—would not find a pathway, would remain unaffected.

Similarly, only a magnetic particle, released as shown, discerns the existence of magnetic curvature and finds its pathway. Incidentally, electrical particles in motion have a magnetic aura about them, so a moving electrical charge would also discern the presence of the magnetic curvature around a magnetic pole.

An electrical body would, similarly, provide pathways for electrical particles.

Of course, if the released or thrown magnetic or electrical particle has the *same* sign as the central body, then another kind of contouring occurs—but it still occurs.

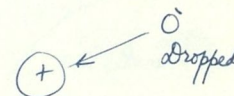
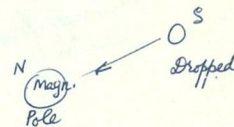
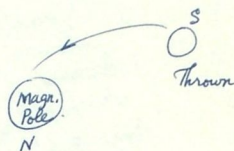
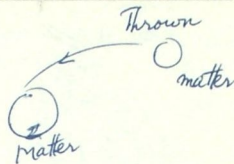
One begins to wonder if there are *matter* particles of an opposite kind which might find a going-away curvature when near a body of ordinary matter.

But before we go along on this new pathway, let us state that Einstein tried hard to do the following: "Weld" the three types of curvature—matter, magnetic and electric—into one general matter-magnetic-electrical curvature. He felt that there was a basic unity among these curvatures—curvatures that others called gravitational force, magnetic force and electrical force.

The work of space unification was not completed. In the Earth-year, 1955, Albert Einstein, Earth-born Universe Scientist, died.

Is there a hidden "curvature"—a unity of all causes, effects, pathways . . . ?

In our discussion of the Special Theory of Relativity, we have talked about space travel and the slow-down of time due to the *speed* of the space-ship. But the General Theory of Relativity, too, has something to say about the rhythm of time: A change of time rhythm occurs if there



"Make up your mind"



runs
slower
because of
rocket speed;
runs faster
because less
gravity!

Earth

is a change of gravitational field or an acceleration or a deceleration (as they are equivalent to a change in the gravitational field). Thus, it is true that when a rocket leaves Earth, it begins to have a slowing of time due to speed, but it also begins to have a *speed-up* of time due to the fact that the rocket is further away from the Earth and hence is now in a region of smaller gravitational field. But these two effects do not have to cancel out. They do cancel out for one definite position above the Earth and for one definite velocity of the rocket: At 2,000 miles above the Earth, if the rocket has orbital velocity. There would not, however, be cancellation at another height.

Above 2,000 miles, a clock orbiting in a satellite would run *fast*, when everything is taken into account, and so we would have a fast-aging situation. But Earthlings do not have to accept that situation. Why just travel in an orbit up there? Aren't we going some place?

We can do the following: Go travelling *away* from Earth, travel *very fast*, and produce acceleration ("gravity") in addition. We would then have the effect of both speed and gravity working together for the *slowing* of time. As an example, accelerate at 2 g (change in velocity by 64 feet per second, every second) and keep that up. We will then have slow time because of the great eventual speed, and also because of the increased "gravitation."

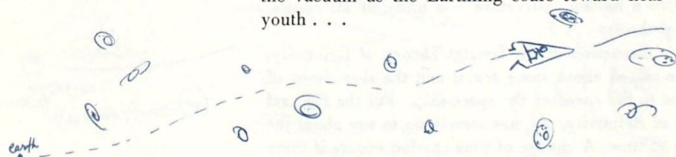
To take an example, suppose an Earthling leaves his planet and travels at a constant acceleration of 1 g (speed *changing* uniformly by 32 feet per second every second). He goes and he goes and he goes.

A time will come when 21 years have elapsed for the traveler. He has passed galaxy after galaxy and traveled about half way to the edge of the known Universe—a distance of about one billion light years. On Earth, more than a billion Earth-years have elapsed.

What is the catch? Is there a catch?

One needs a lot of fuel to keep up the acceleration all that time. It can hardly be carried along—it is an enormous quantity.

But, we recall, space is not empty. Even the vacuum is not empty. Perhaps the fuel will be plucked out of the vacuum as the Earthling soars toward near eternal youth . . .



Anti-Matter

Anti-gravity and anti-worlds.

IN THEIR JOURNEYS through very distant space, Earth-people will have one small lurking worry: "What if we meet up with anti-matter?"

If they do, they'll be annihilated in one sizzling breathless moment, turning into light, X-rays and gamma rays.

But that could only happen if Earthlings travel really far—out of their solar system and further, out of their galaxy.

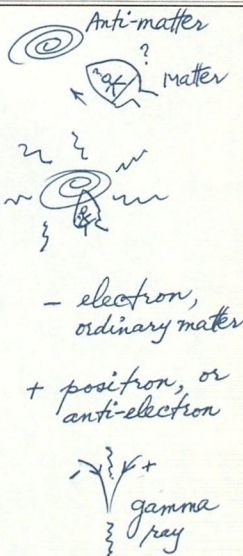
"There is a chance," some Earth-scientists reckon, "that part of the Universe is made of anti-matter, which annihilates ordinary matter and itself, on contact."

The first anti-matter particle was discovered on Earth in the year 1932. This was a charged particle, equal in mass to the electron, but opposite to it in sign. It is called a "positron."

Positrons and electrons annihilate each other on contact, producing pure energy—gamma rays.

Positrons can now be created in certain elements when they are bombarded by fast particles. These "target" elements become radioactive and emit positrons. Positrons also exist in the cosmic rays reaching Earth, so they are out there, in space.

The next anti-particle was created in the cyclotron



$\oplus$ proton

$\ominus$ anti-proton

n neutron

$\bar{n}$ anti-neutron

through conversion of energy into matter—the anti-proton.

Protons and anti-protons destroy each other, first converting themselves into smaller particles, which finally decay into pure energy.

Anti-protons are not yet available in quantity, but Earthlings realize that anti-protons may inhabit extended regions of space.

The third "anti-particle" is the anti-neutron, a neutral particle which is like the neutron of ordinary matter, but has an opposite magnetic effect. Neutrons and anti-neutrons also annihilate each other.

The three basic matter particles may be combined to give the known atoms, and the three basic anti-particles may be combined to give the atoms of anti-matter.

Other anti-particles besides anti-protons, anti-neutrons and anti-electrons have been found in nuclear work; for example anti-muons, anti-pions, anti-K-mesons.

Some Earthlings have wondered whether or not anti-meteors might have crashed into Earth, and caused huge craters. "Perhaps," they say, "anti-meteors have come to us from weird anti-galaxies, anti-worlds. In such cases, no trace of meteor material would be found because of instant annihilation."

These Exist

$- +$

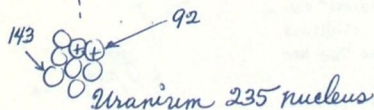
$\oplus \quad \ominus$

$n \quad \bar{n}$

$\oplus$ heavy hydr. nucl.

$\oplus$ very heavy hydr. nucleus

$\oplus$ helium nucleus



These Exist

$\oplus$ hydrog. nucl.

$\downarrow \oplus$ hydrog. atom

Only the 1st Exist,
So Far

$\ominus$ anti-prot; or,
anti-hydr. nucleus

$\downarrow \ominus$ anti-hydr.
atom

$\bar{n}$ anti-heavy hydr.
nucleus

$\bar{n}$ very heavy anti-hydr.
nucleus

$\bar{n}$ anti-helium
nucleus

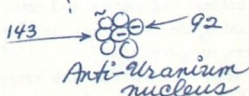




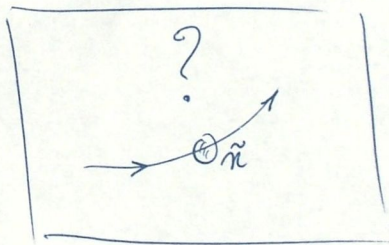
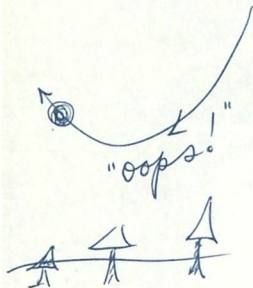
FIG. 18—Collision of two galaxies.

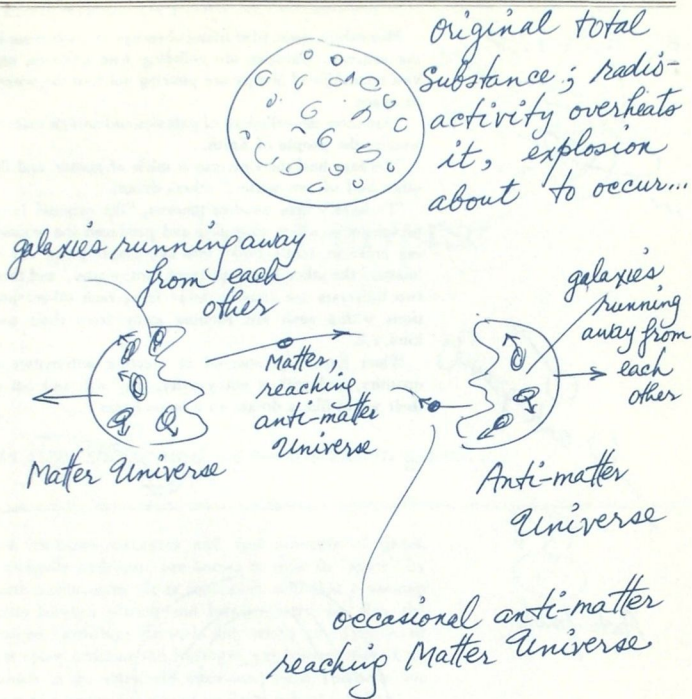
Earthlings remember especially the huge meteor of June 30, 1908, which swept over central Siberia, crashing into a forest. The explosion was like that of a hydrogen bomb, with destruction extending to almost 100 square miles. The craters which were produced are small, however, extending as little as 30 feet by 150 feet, with a depth of only 12 feet. No meteorite fragments were found by Russian diggers to a depth of 30 feet—with the exception of some tiny grains of nickel-iron. "This," say the scientists, "indicates that the blast may have been the result of matter annihilating matter at the very first touch, and not due to an ordinary impact and boring in."

Others point out that anti-matter should explode immediately upon entering Earth's atmosphere. That is, the anti-matter should engage in mutual annihilation with the atmosphere, and not wait until it reaches the ground.

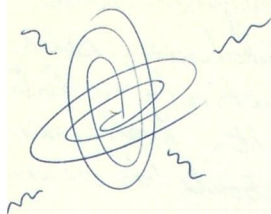
"Besides," say some Earthlings, "shouldn't anti-matter be possessed of anti-gravity? So, an anti-meteor would not come down—and annihilation would not occur."

Does anti-matter have anti-gravity? Earth-scientists are designing experiments to find out. One plan might be this: An anti-neutron released over the surface of the Earth—in a laboratory set-up—might rise, instead of falling. Will it?





Two Expanding Universes
Running Away From
Each Other



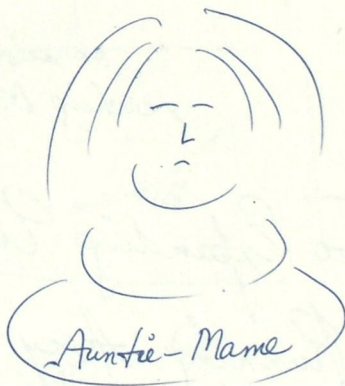
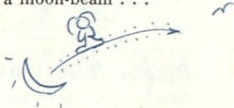
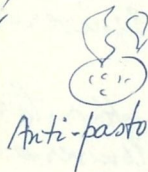
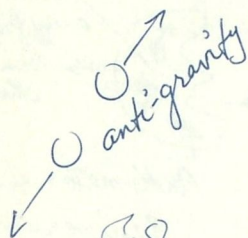
Meanwhile, great liberations of energy are occurring in the heavens. Galaxies are colliding with galaxies, and vast quantities of energy are pouring out into the oceans of space.

"Are these the collisions of galaxies and *anti-galaxies*?" wonder the people of Earth.

"Perhaps half the Universe is made of matter, and the other half of anti-matter," others dream.

"Perhaps," says another theorist, "the original lump of substance which exploded and produced the expanding universe, really broke into two major parts, one of 'matter,' the other its complement, 'anti-matter,' and these two universes are running away from each other; portions within each are running away from their own kind, too."

When Earthlings succeed in creating anti-matter in quantity, and with it anti-gravity, they will sail out of their world like a dream on a moon-beam . . .



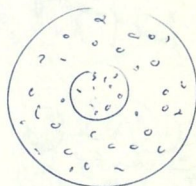
The Universe

Its size, shape and age—an Earth-guess.

ONE TRILLION GALAXIES and vast amounts of gases, principally hydrogen, are known to exist in "space" by Earth-astronomers. It is commonly said that a vacuum exists between planets and between stars, but this, the learned Earthlings know, is not strictly so. They know that space contains the hydrogen gas just mentioned although in an extremely attenuated form (perhaps one atom to a region the size of an Earth school building).

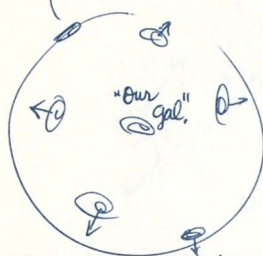
Many Earth-men would call this a vacuum, but they realize that when considered collectively throughout all the reaches of space, this amount of hydrogen gas adds up to so much matter that it totals more than the matter of which all the stars, planets, and meteors are composed.

Some Earth-people want to inquire about other galaxies, those beyond the one trillion already within the reach of the best telescope. As we construct better telescopes, we may expect to see and photograph more galaxies. But there is a limit to this process. After building a telescope which might be "twice as good" as the one at Mount Palomar, we should profit little by attempting to construct a more far-reaching telescope. Now what is the meaning of this statement? A telescope which can "see" twice as far as the Hale telescope at Palomar will be a telescope which sees the furthest possible into the



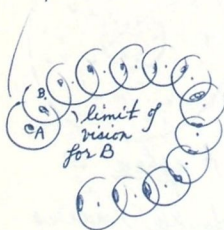
*A sphere of
double radius
has 8 times the
space*

"Theoretical limit of vision, a galaxy moving at about 186,000 mi/sec"



An Earth-Astronomer's View

limit of vision for A



Each radius 2 billion light years

Universe! The Palomar telescope can see to a distance of two billion light-years, and within that distance it is able to reach one trillion galaxies. The telescope which would be twice as far-seeing would look into a volume of space eight times as large as the Hale telescope and accordingly could expect to see eight times as many galaxies—that is, eight trillion.

But now why not build a still better telescope to see further? Because soon we would have a telescope which would be trying to bring into view galaxies which are rushing away from us with the velocity of about 186 thousand miles per second, which is the same velocity as that of light.

The space between us and such a galaxy is increasing at the rate of 186 thousand miles per second, and a ray of light leaving the galaxy would start to travel toward us at the same velocity but it could never make up for the stretching distance. At best, it could only participate in a tie race. Therefore, the light coming to us from such a galaxy would never actually reach us, and we would never see it, nor could we photograph it. Thus it is that there is a limit to how far we can ever hope to see, and better telescopes will not help us to see any further.

It should be clear, now, that any so-called superior telescope could not see any further into space than where matter is moving away so fast that its light cannot reach us. On the other hand, it must be admitted that a superior telescope might conceivably be worth building, not for the purpose of seeing further (which it couldn't), but for the purpose of seeing what we have already seen but seeing it more clearly.

One can ask, of course, do galaxies nevertheless exist beyond those which are receding from us with the velocity of light? To answer this question, one might say that it makes little sense to speak of any more of the Universe than that which we have described, because there is no way in which we can become conscious of this extra portion, if any.

Instead of falling into an argument over this point, let us show an easier way out by admitting that an observer who lives on another galaxy will be able to see further than we could, because he is already at a distance from us. A galaxy which is moving away from us at 186 thousand miles per second, is moving away from him at less than 186 thousand miles per second, because he himself is on a galaxy which is rushing away from us at a certain speed.

We can continue this process further and imagine that there is another observer—as there surely must be—on a galaxy which is still further away from us. For this still-further galaxy, again a limiting distance will exist and therefore this observer can see further than the previous one. On the other hand he cannot see as far backward . . .

To summarize the situation, we can say that each observer, no matter on which galaxy, can see a definite number of billion light-years into space and this process can continue indefinitely. It might be indicated that on this basis there must be a galaxy and an observer who cannot see us because we are beyond his limiting light-year radius.

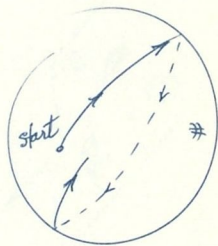
What is the outcome of all this? Where does it lead us? Does this go on ad infinitum?

As a matter of fact, though it would seem that such a situation should go on indefinitely, there is a possibility that it does not. It is possible that eventually some distant observer on one of these greatly removed galaxies, while looking forward, will actually see us from the rear. That is to say, the Universe may double back on itself or fold up on itself and make a closed space-time.

To meet the inquiry of those who say "but what is beyond this pace, outside this space?" we will state that the situation has to be examined carefully and in detail to make sense. In order to give an explanation of the apparent dilemma into which we have led ourselves, we will proceed by first giving an analogy.

Let us for a moment consider a special type of bug having only two dimensions—those of length and width but no dimension of thickness. Let us further assume that this bug lives in the skin of an ivory ball, say a billiard ball. Or, he lives on this ball, but he fits into the surface since he has no thickness. Let us assume now that this bug decides to go exploring. He can move in any direction—left, right, forward, or backward—but he cannot leave the ball because he has no three-dimensional powers.

The bug goes exploring upon the surface of the ball, saying to himself, "I will go in a straight line. I want to see how big this Universe is in which I live." He sets out along the surface of the ball, and to him, his advance is a *straight-line* advance. He has no feeling about the contour effect of the ball, because he cannot lift his head. He continues in his "straight" line and eventually makes a complete circuit around the ball, possibly returning to his starting point.



But for the moment let us say he misses the starting point and is still to be seen plodding onward, pacing off his universe. So he goes round again at a somewhat different angle in his supposed straight line—over, down, around, and up again, looping once more and down and under and around and looping once again and again and again.



The bug might decide after a sufficiently tiresome series of excursions that his universe seems like a universe without end—it seems like an infinite universe, and yet he cannot comprehend the meaning of infinity. For a moment let us assume that he stumbles upon the starting point. If this is the case and if he is quite brilliant—an Einstein type of bug—he might rejoice with the scientific light which dawns upon him and exclaim, "Why, it is remarkable! I must write a book about this. One can go in a straight line in this universe and come back to where one started from."

It may dawn upon the bug to regard his universe as a universe without a boundary, but of definite size, because nothing stopped him; he came to no barrier, and yet he came back home. This Einstein-type bug may realize that he can do nothing different; he might even say, "That which seemed to me like a straight line apparently is not really a straight line!" He may even have some vague longing to go in a different kind of path such as through the billiard ball, but he can have no really genuine appreciation of such a possibility, because he is not built that way. He is built two-dimensionally and he can not enter into a third dimension.

Those of us who are three-dimensional and who may look upon this billiard ball and the scientific bug, could understand his situation even as he himself almost understands it. In our superiority we could easily remark that the billiard ball or the universe of the bug is truly unbounded as he has guessed, but at the same time of a finite or definite size. There it is, a mere handful, a definite size, but with no boundaries for the two-dimensional bug. Can he speak of "What is there beyond?" He may speak of this, but the question is without much sense for him because he cannot possibly experience the beyond. He is constructed differently. Therefore he should learn to understand that, as he is beginning to suspect, he really lives in a universe without boundaries which closes in upon itself and has a definite size.

Now it will be clear that the situation of Earthlings is very similar to that of the bug on his billiard ball. We



might set out in a straight line on a flying saucer, flying through space, endlessly forward, diligently clinging to a straight-line flight, and we could eventually return to the starting point in spite of our forceful determination to go "straight out there."

We are three-dimensional beings exploring our Universe, traveling in our straight line, but a four-dimensional being—if there is one—could look upon us and realize our situation even as we realize that of the bug. The four-dimensional being could see that we who live in a three-dimensional world and who travel in what we call a straight line, are actually, from the point of view of the four-dimensional observer, traveling in a curve. It will be recalled that the bug's "straight line" was, to a three-dimensional observer, clearly a curved line which led him back home; similarly, that which to us (three-dimensional beings) seems like a straight line is to a four-dimensional being actually a curve which could lead us back home.

Thus, one might find a feeling of contentment with regard to the words "endless space," "infinity," "beyond," etc. We can find this intellectual contentment by realizing that our Universe is without boundaries but yet is of a definite or finite size.

So our Universe is a shining ensemble of galaxies which perhaps somehow doubles back on itself, leading us always home again, like a majestic shining mother watching over her straying children.

But there are other notions, too, of the size and shape of the Universe. One theory holds that the Universe is "straight," stretching endlessly, infinite, and expanding, too.

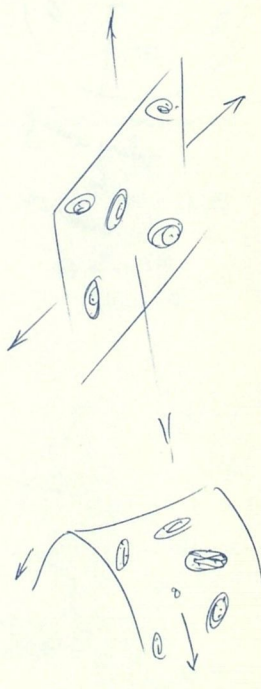
Another theory holds that the Universe is infinite, but negatively curved—and expanding, too. It may be possible for Earthlings to discover the architecture of the Universe by studying the distribution of galaxies in space.

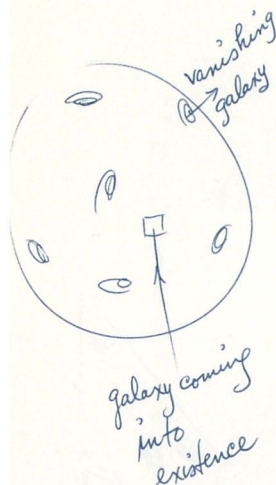
In any case, these are the thoughts of some scholarly Earthlings. This is how they feel about the unending wonder of creation.

Does Time Flow?

Now that we have some feeling of satisfaction with regard to the question of the *size* of the Universe, we might think a little about *Time*, and how long it has gone on, or could go on.

Taking for the moment the views of the British mathematician-astronomer, Hoyle, we might proceed as follows to the examination of the idea of a "beginning of



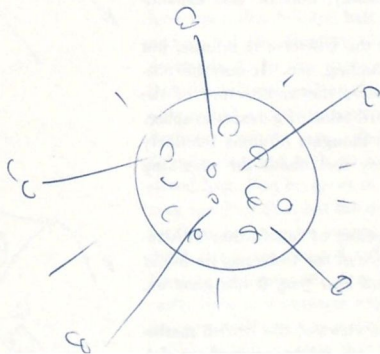


the universe" or the "creation of the universe," and consequently the "beginning of Time."

Hoyle and his colleagues believe that it is possible to think of a universe which *never* actually was created, *never* had a beginning, but always existed, merely undergoing changes. If we can understand this and believe it, then Time never had a beginning. Hoyle calls this kind of universe a "universe in flux." He means by this term that the universe is always undergoing changes—the formation of galaxies and planets and the disappearance of galaxies and planets, the conversion of hydrogen to helium with the disappearance of mass and in its place the appearance of radiant energy.

Hoyle has even made calculations as to just how much hydrogen gas must appear in a unit of volume per unit of time to make up for the loss of mass which occurs when the galaxies travel away with the velocity of light, as was mentioned in the previous chapter. Thus, according to Hoyle, matter remaining in our knowable Universe changes in amount when the galaxies go "over the border" at a distance of several billion light-years. On the other hand, hydrogen somehow appears within our reach or within our view to take the place of the lost galaxies. This particular aspect Hoyle calls "continuous creation" in a universe of flux.

In contrast, along with Abbé LeMaitre, we can think of a definite moment of "beginning"—the moment, for example, when the primitive atom exploded. Or, if we like, we can reckon time from the moment the Earth was created.



Out of this World

To space and eternity.

THE UNIVERSE has no limitations. All of the *known* Universe is but an "atom"—and even the whole of this atom is not yet thoroughly known to Earth-people . . .

Once upon a time, Earthlings thought that their region—called "Europe" and "Asia"—constituted THE UNIVERSE. Later, they thought that other regions and great oceans made THE UNIVERSE, and they called it "Earth." The heavens moved around this "Earth."

Still later, Earthlings learned that the Sun had a family, and Earth was only one member. The family circled the Sun, and the Earth rotated as it traveled through space.

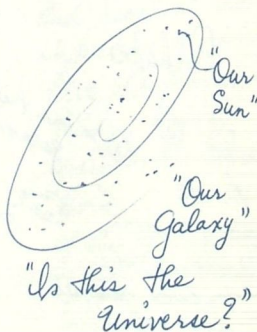
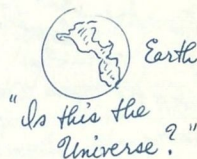
Then came the knowledge that other stars were suns and had families of their own.

The Universe grew. Or, rather, the *minds* of Earth-people grew; the Universe only waited to be discovered.

"Our Galaxy," sang the people of Earth. "How large it is!"

There are other galaxies. A trillion of them are within reach of Earth telescopes. But Earth-telescopes are puny. The known Universe is not much known, and it is only an atom.

There are no limitations to the Universe. There is distance without end, energy in the vacuum, life replacing death, aspirations becoming reality.





Limits of the
Known Universe

In another per-
spective,

And what is
beyond?
Limits of the
Known
Universe

The Universe is for the dreamers, for Earthlings who know that the material is nothing, the spiritual is all.

"I feel a religiosity," said Einstein, contemplating the grandeur, the majesty of the shining heavens.

And it is not necessary to board a space-ship in order to go out of this "world"—away from planet Earth, to the heavens, to the furthest reaches, to the suburbs of infinity.

It is not necessary to fly to the Moon, or to Mars, in order to tap on the portals of creation. Earth-people are already in space. The Earth is a space-ship circling the sun. And the sun is in flight toward the blue star Vega. And Vega is rotating about the center of the galaxy. And the galaxy is rushing away from other galaxies—through the great space.

It is not necessary for an Earthling to propel himself to other planets, through persisting spaces, in order to learn of the majesty of existence.

It is only necessary to know that Earth-men, if they try, can be like Gods; it is only necessary to know that creation is more wondrous than men have ever dreamed. It is only necessary to sense the religiosity of the cosmos, to comprehend that the Universe is great, and Man can be great. It is only necessary to understand that Earth-men are not alone in space, and no man is alone in the Universe. It is only necessary to understand that there is a Superior Being, and that Man must live with his face to the heavens.

Then Earth-Man becomes a part of infinite space and unending time. Then Earth-Man enters upon eternity.

THE END

Perhaps

one trillion
galaxies
Limits of Known
Universe, one
trillion galaxies
one trillion
galaxies

Afterthoughts

If you're about to leave Earth . . .

I. Space travelers from Earth will be able to avoid excessive radiation by taking three precautions: (1) shielding the space-ship with lead; (2) traveling very rapidly through the intense radiation zones around Earth; and (3) leaving the planet through the relatively radiation-free "escape hatches" over the North and South Magnetic Poles.

Outward-bound Earthlings must be warned, however, that the danger of radiation contamination will exist if nuclear fuels are used indiscriminately, particularly on take-off. The exhaust would be more dangerous than the radiation in space.



*Bone
Radioactive
(one week
old)*

*Experiments performed
by author with
the cooperation of
space-minded ani-
mals shows mo-
ther, on left, who
had received an
injection of radioac-
tive phosphorus-
4 days before
young ones were
born . . . All 10
of the offspring
were radioac-
tive & their radio-
actions produced
pictures.*



II. All but one of the planets have orbits lying in almost the same plane, called the "ecliptic." (Pluto's orbit is at an angle of about 17° from the ecliptic.)

III. The time between two successive close approaches of Earth and Mars is a little over two years.

IV. Alpha Centauri is a double star (two stars orbiting about one another). There is also a third star, "Proxima," belonging to the above two, and it is really the closest of all stars to our solar system.

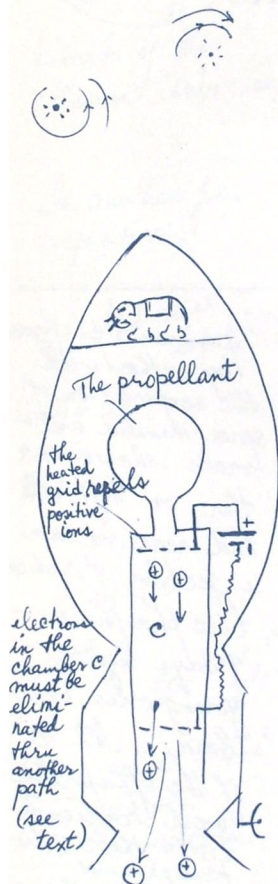
V. Irregularities in the motions of nearby stars indicate that they may have large planets orbiting around them. (One of these stars is "61 Cygni.") Considering stars with such irregular motions as possible "owners" of planets, and counting the number of such stars within view, some Earth-astronomers estimate that within their galaxy alone, there may be from one to ten billion suns with planets.

VI. To reach various planets on a one-shot basis — that is, firing the fuel just once and then coasting all the way — requires at least the following launching speeds:

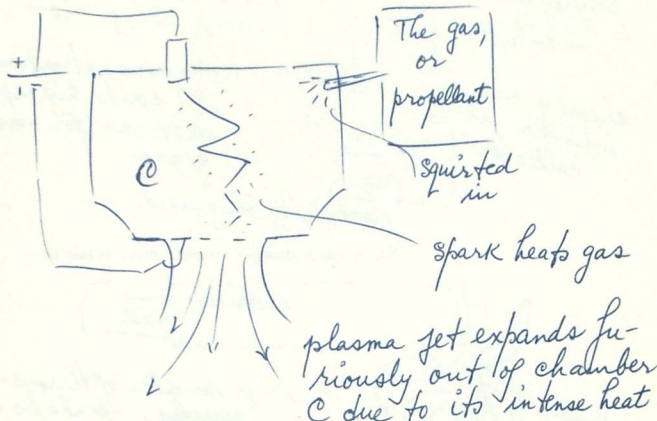
PLANET	SPEED IN FEET/SEC.
Mercury	44,000
Venus	38,000
Mars	38,000
Jupiter	46,000
Saturn	49,000
Uranus	51,000
Neptune	52,000
Pluto	53,000

To escape from the solar system completely, the spaceship would need, on a one-shot basis, a launching speed of at least 54,000 feet per second.

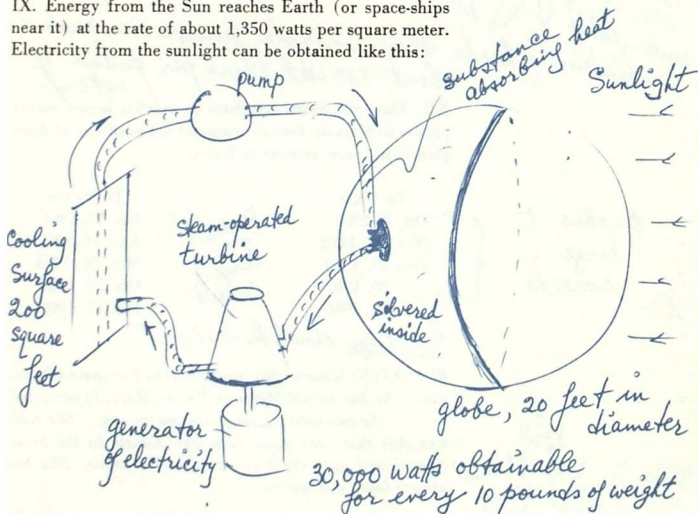
VII. In the ion rocket engine, the charged particles, or ions, can be produced by passing a gas (such as gaseous cesium) over metallic grids which are heated. The positive-charged particles are then accelerated out of the nozzle by a voltage difference.



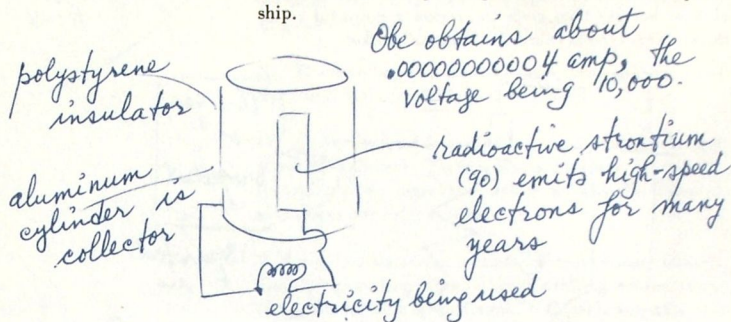
VIII. In another type of fuel chamber, electricity is used to heat the gas to a very high temperature. The outward-rushing hot gas then gives the rocket a powerful recoil thrust. This type is called the "plasma" rocket.



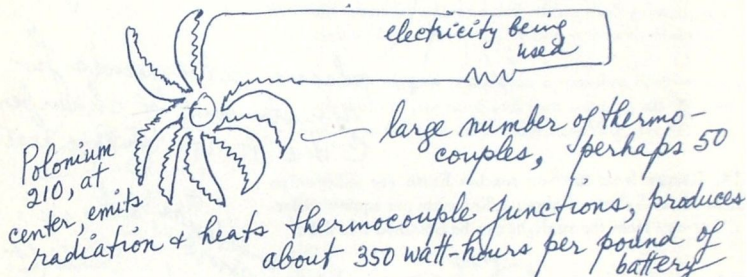
IX. Energy from the Sun reaches Earth (or space-ships near it) at the rate of about 1,350 watts per square meter. Electricity from the sunlight can be obtained like this:



X. An atomic battery (of low power, but long-lasting) could be used for operating delicate circuits in a space-ship.



XI. A much stronger atomic battery is this one:



XII. These will be the best dates on which to launch rocket probes to Mars or Venus because of the positions of these planets in space, relative to Earth.

To MARS		To VENUS	
probes & large rockets	Oct. 1, 1960	probes & large rockets	Jan. 13, 1961
	Nov. 16, 1962		Aug. 16, 1962
	Dec. 23, 1964		Mar. 28, 1964
	Jan. 26, 1967		Oct. 27, 1965
	Feb. 28, 1969		Jan. 11, 1969
↑ <u>Earthlings</u> should be leaving ↑			

BULLETIN: Minerva has just produced five space-kittens, which she has named Mercury, Venus, Mars, Jupiter, and Saturn (the one with the rings around its paw). She realizes that there are more than five planets in the Solar System and says she'll see what can be done. She has always loved astronomy.

